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CIVIL ENGINEERING

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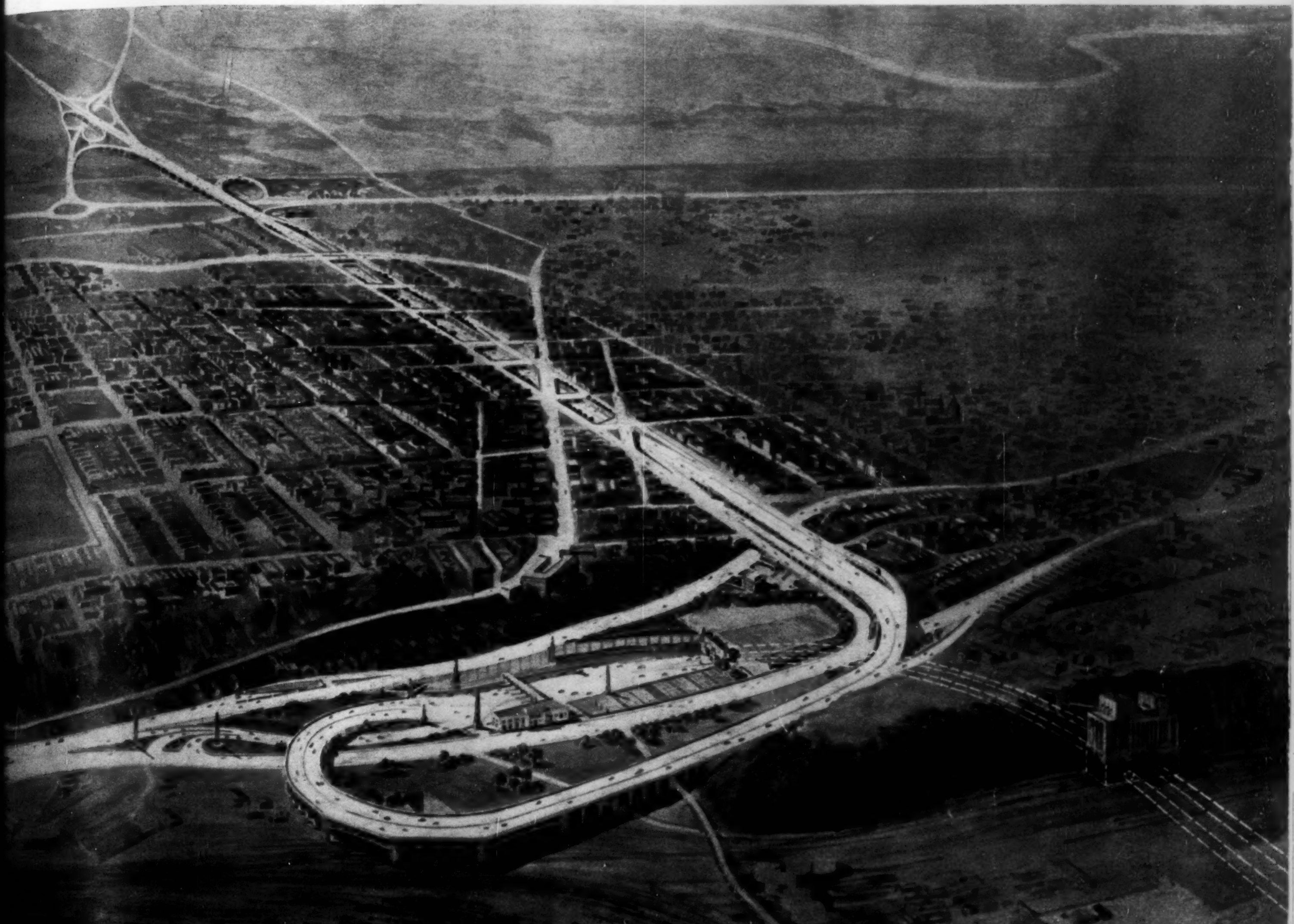

Extensive New Jersey Approaches Connect Lincoln Tunnel with Adjacent Traffic Arteries ~ *Rendering by A. Gordon Lorimer*

Volume 7 ~ AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 6* ~

JUNE 1937

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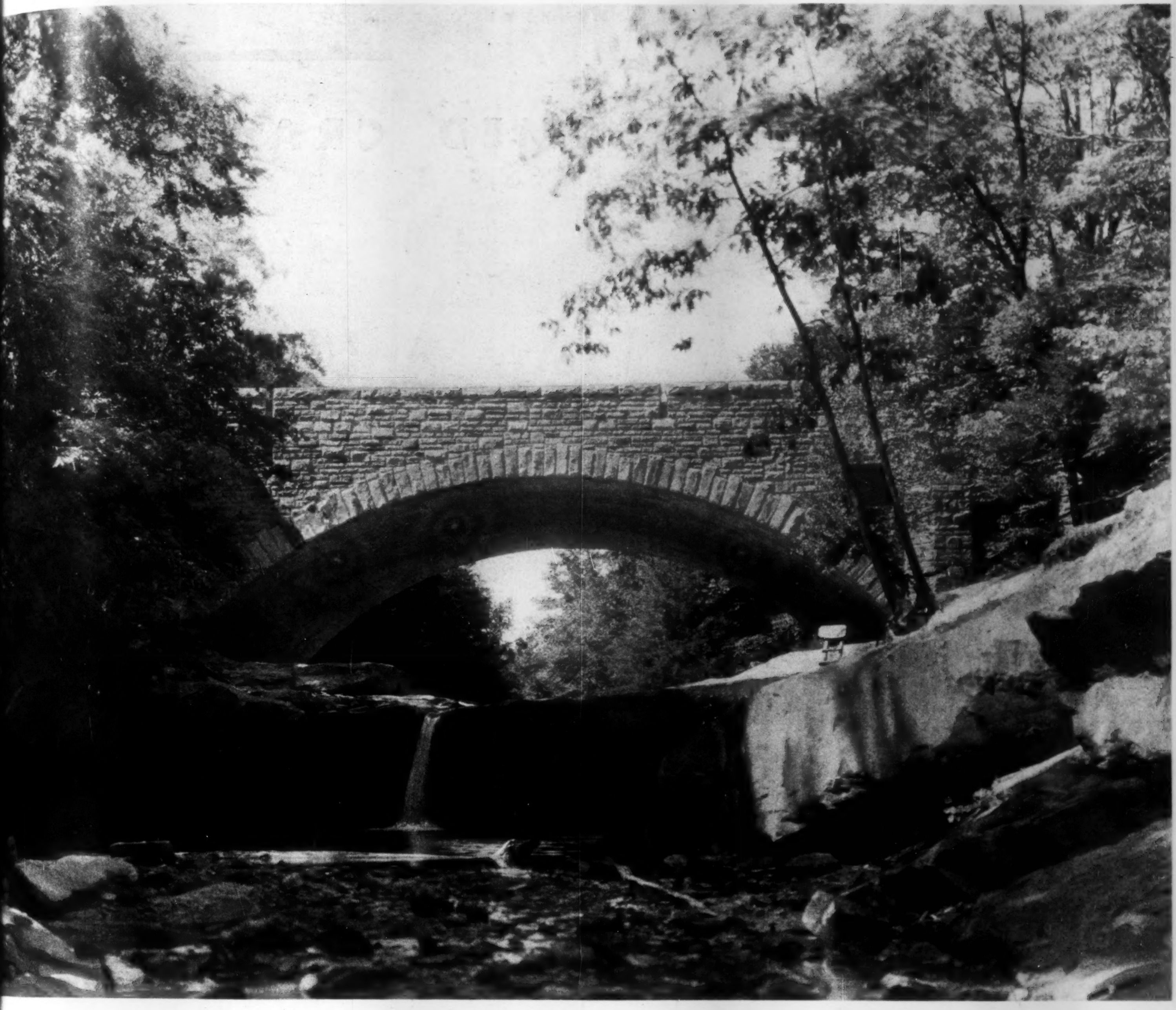
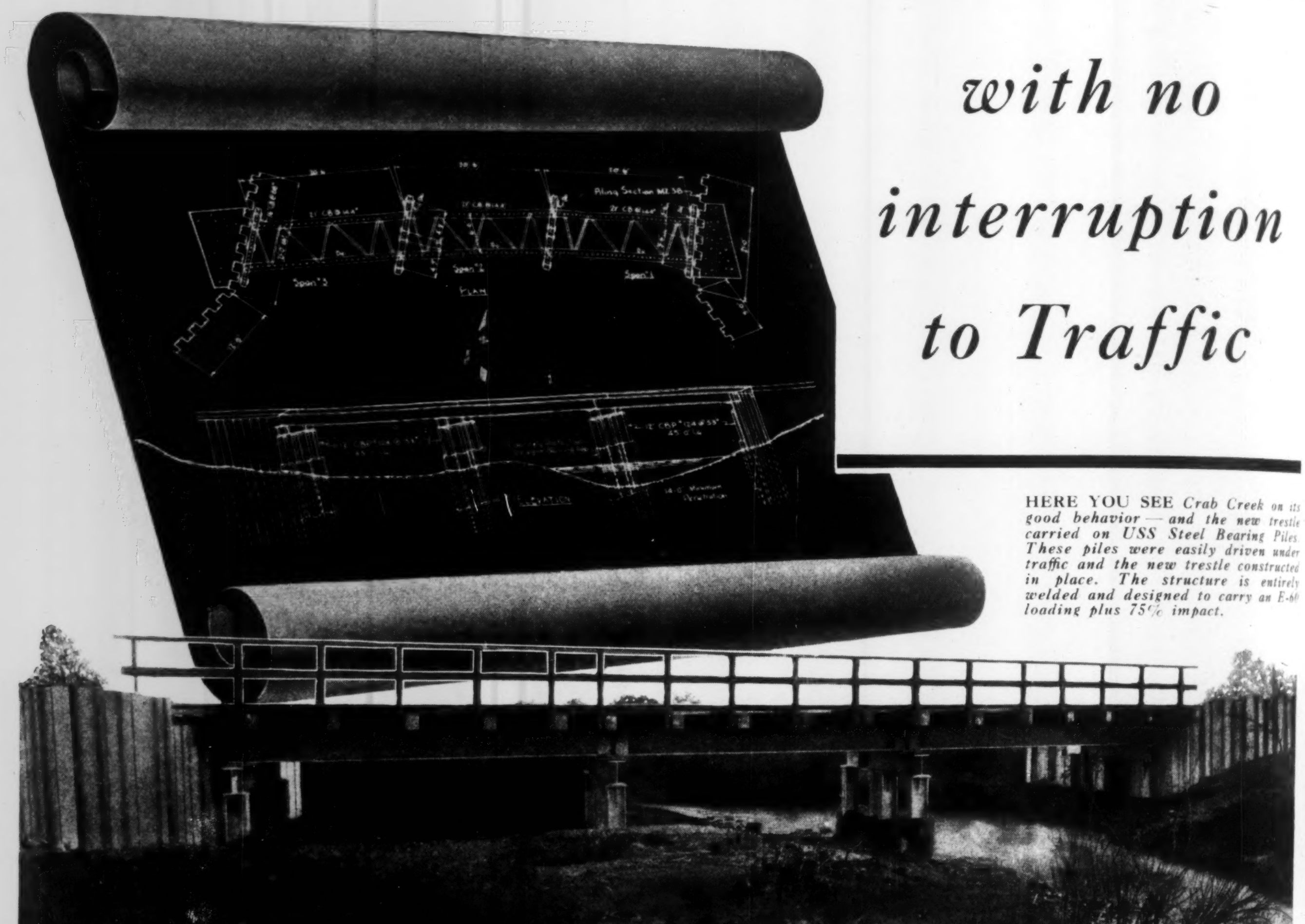


Nature Sets the Stage for the Artistry of Man

A Stone-Faced Hollow-Spandrel Arch on Ohio State Route 52 in the Cleveland Metropolitan Park

HOW THEY TAMED CRAB CREEK

with no interruption to Traffic



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Among Our Writers

Abel Wolman entered the employ of the Maryland Department of Health in 1914 and rose to be chief engineer in 1922. Since 1934 he has also been acting PWA director for Maryland and Delaware. In addition he has served as editor of several sanitary engineering periodicals, since 1921 as editor-in-chief of the *Journal of the American Water Works Association.*

George R. Clemens has been engaged on Mississippi River work for the federal government since 1927, first in Washington during preparation of the Jadwin plan, thereafter in Vicksburg (1928) as assistant to the chief of the general engineering division charged with preparing the "308" reports. Since 1932 he has been senior engineer in charge of hydraulic and dredging sections.

Bruce D. Greenshields holds M.S. and Ph.D. degrees in civil engineering, as well as a professional degree, and has taught in this field since 1922, specializing in highway subjects. He originated the photographic method of studying traffic, and has conducted traffic studies in Michigan and Ohio. Dr. Greenshields is the author of numerous articles on highways and traffic.

O. H. Ammann has had 33 years of experience in the design and construction of bridges in the United States. Since 1925 he has been connected with the Port of New York Authority, for the past 10 years as chief engineer in charge of the Outerbridge Crossing, Goethals Bridge, Bayonne Arch Bridge, George Washington Bridge, and the Lincoln Tunnel. Since 1934 he has also been chief engineer of the Triborough Bridge Authority.

Warren J. Mead taught geology at the University of Wisconsin prior to 1934, when he became professor of geology and head of the department at Massachusetts Institute of Technology. For the past 30 years he has been consultant on many foundation and dam-site problems in this country and elsewhere, including among others those at Boulder Dam and Madden Dam.

John A. Oakey holds B.S. and M.S. degrees in civil engineering. He has taught civil engineering since 1929, successively at Texas Agricultural and Mining College, University of Wisconsin, Purdue University, and Columbia University. Mr. Oakey has also had several years' practical experience in design and construction.

Philip Kissam, after graduation from Princeton University in civil engineering in 1920 and some experience in industry, entered the teaching field at Princeton in 1921. Since 1935 he has been associate professor at that institution. He organized the N. J. Geodetic Control Survey, and acted as director and later technical adviser until March 1937. He is the author of a number of articles in technical publications.

C. W. Ogden has had over 30 years of experience in bridge design and construction, including 4 1/2 years with the Roanoke (Va.) Bridge Company, 2 1/2 years with the American Bridge Company, and the remainder with the Virginia Bridge and Iron Company (now the Virginia Bridge Company). Since 1922 he has served as assistant chief engineer of the latter organization.

E. Lawrence Chandler, after some years in municipal engineering work, became connected with the Miami Conservancy District's flood-control project. Following 12 years of construction work, principally on hydroelectric developments in the Middle West, he became chief engineer for the Chattanooga Flood Protection District. At present he is with the Tennessee Valley Authority.

Volume 7 Number 6

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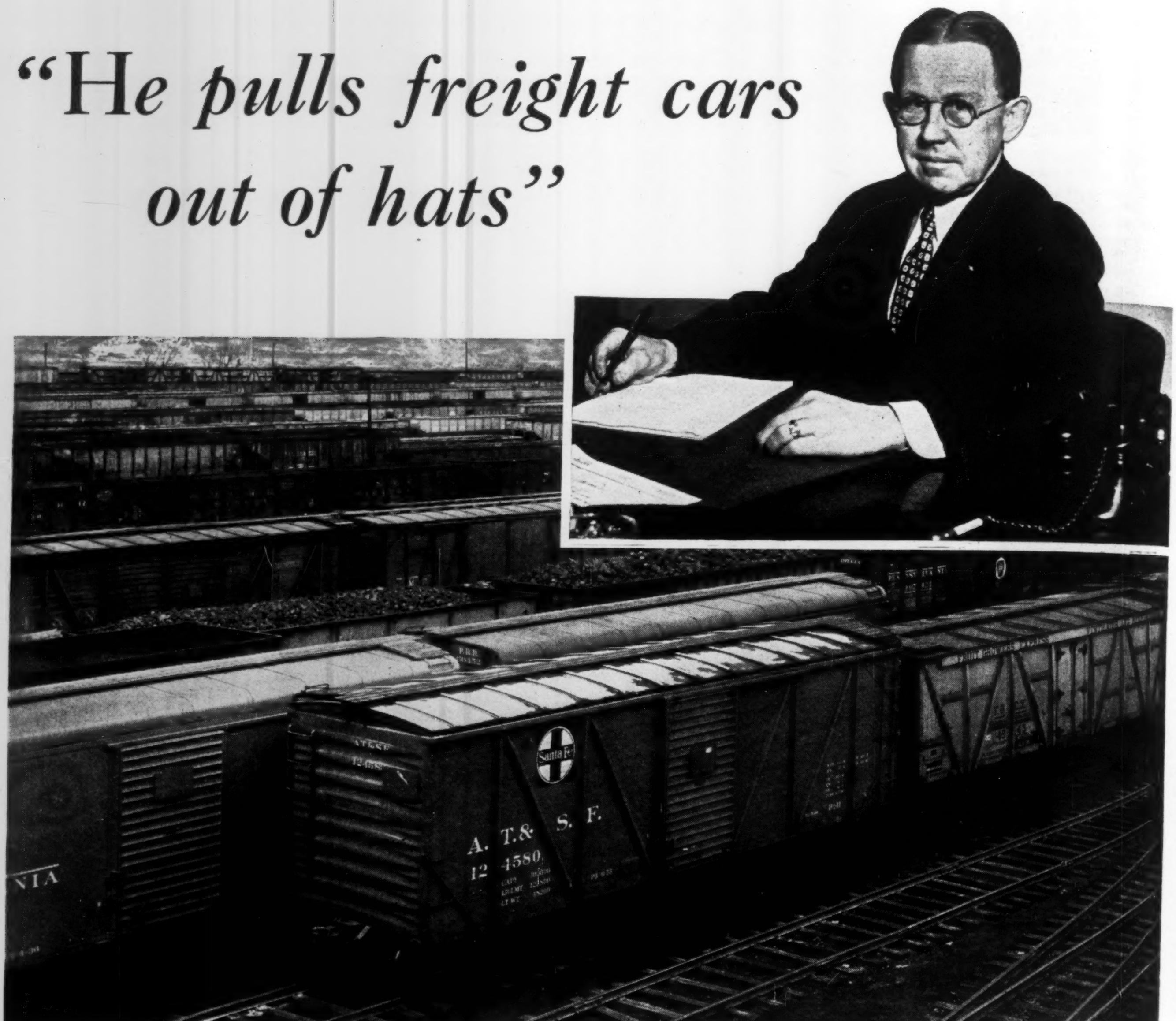
"He pulls freight cars out of hats"



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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

The Engineer and Society

Extracts from an Address Before the Alumni Association of Johns Hopkins University on February 22, 1937

By ABEL WOLMAN
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, STATE DEPARTMENT OF HEALTH, BALTIMORE, MD.

IT has been the fashion in the learned professions of recent years to point out the confusions into which our present society has lapsed. Writers "view with alarm" the breakdown of modern society and search for cures for what they believe to be the modern twin diseases, overgrowth and mechanization. Whether we follow the gloomy banner of a Spengler to world destruction or the aspirations and hopes of the rhythmic Toynbee, the undercurrent is one of pessimism both as to the problems and the solutions of the present-day world.

Some Notable Observations.~Leaders of the bar, that is, those above or below the age of 70, depending upon current alignments, take at least partial responsibility for the collapse of modern society. One of its recent spokesmen, Arthur T. Vanderbilt, chairman of the National Conference of Judicial Councils, states: "The future of the bar is not an isolated problem .... An inevitable transformation in our mode of living and our habits of thought is taking place as a result of the impact of our tremendous advances in the realm of the physical sciences on our relative inertia in the field of the social sciences. This presents a sharp challenge to every existing social institution, the bar included."

A distinguished scientist, President Karl T. Compton of the Massachusetts Institute of Technology, makes the comment: "We have reached the point beyond which further increase in our wealth, population, physical comfort, and cultural opportunity will not depend on discovering new resources by geographical exploration, but by wiser use of the resources that we now have, through scientific exploration." He points out that "This idea is not new, but I doubt if we realize its profound significance; it marks a turning point in the history of the world."

The social science historian, as represented by Charles A. and Mary R. Beard, joins the procession with the warning, "Let the engineers and the scientists quit and the whole cultured order will revert to that of eighteenth century agriculture."

These rumblings about the deficiencies of modern society have even led certain less timid souls to point out how we may be saved from destruction. Alexis Carrel holds out high hopes: "For the first time in the history of humanity, a crumbling civilization is capable of discerning the causes of its decay. For the first time, it has at its disposal the gigantic strength of science."

Can the Engineer Be Blamed?~These observations are unanimous only in the conclusions that there is something wrong with our universe, that the advances of science have had something to do with it, and that the engineer in particular is the unfortunate, if unconscious, Satanic Majesty who has cast us all into this pit of despair. So strong are these charges that scores of distinguished orators, usually quite unfamiliar with the scientific field and frequently running for office, have bravely called for complete "intellectual disarmament," for a cessation of research, for a penalty on technological advance, for a return to the Garden of Eden or to the agricultural havens of some of our not distant international neighbors.

These gropings for the "simple life" are only partially explained by depression psychology. They gained force from, but did not originate with, the bank holidays. They rest upon a more solid base. People, both lay and professional, sense a restriction upon their hopes and capacities, which restriction they believe is somehow linked with pernicious scientific advance. What form this suspicion has assumed is immaterial for the purposes of our discussion. What is important is the inescapable conclusion that science, which has made modern life safe, comfortable, and easy, is conceived to be the enemy rather than the friend of man.

For this reaction against science in general and the engineer in particular, at least part of the responsibility rests upon the engineer. Both the engineer and the scientist have restricted their spheres of usefulness in the past to only two of the three possible opportunities in society. They have combined the functions of applying the fruits of science and of creating and expanding the sciences which make these applications possible. An intermediate field, however, appears to have been missed. It is a field that has been preempted for the most part by individuals alert to public opinion, active in debate, but extraordinarily deficient in fundamental data. To these men, the engineer has generally been the "subordinate in the waiting-room, not the equal in the council chamber."

The engineer has contributed to the general welfare by reducing drudgery, by providing new entertainment, by saving time, and by increasing material possessions. His failure, perhaps, has been in the field of "social transfer," in not assuming wider responsibility for fitting scientific contributions into the general social fabric, and not participating in those activities which would permit the universal enjoyment of the fruits of the labor of science with the least dislocation of the social structure.

Facing a Vital Responsibility.~We submit that a future task must be added to the present accepted functions of the engineering profession. That task is to transform the creations of science into the opportunities of society. The engineer has a peculiar responsibility in this task, that of conversion, since he has been trained to substitute knowledge for guesswork in dealing with technological problems. When the engineer undertakes the tasks of conversion here suggested, he automatically embraces an activity largely in the field of public service. He must deal with problems which are not only technical in character, but which also involve a knowledge of economics, finance, and above all an understanding of human relations. The days when an engineer could be only a technical expert in a highly specialized field, are gone. One or two examples of modern engineering problems may emphasize this point and serve to clarify suggestions hitherto stated only in general terms.

Ohio Valley Illustrates the Difficulty.~Most readers have still fresh in mind the recent catastrophic floods on the Ohio and Mississippi rivers. Probably few, however, have stopped to enumerate the engineering, legal, financial, and administrative problems which these floods dramatize in the technical field. No one doubts that the human and material damages which these floods have caused will be met. Perhaps the public mind may be temporarily satisfied by these concessions. The long-term difficulties remain, however, in all of the fields mentioned. Upon their solution, future safety, economy, and public welfare rest.

The Ohio River is a sewer, a source of water supply, an outlet for floods, and a highway. One-seventh of the population of the United States is concerned directly with the waters of the Ohio Basin. A brief consideration of the problems raised by these conditions discloses engineering difficulties, comprehensive in scope and involving hundreds of millions of dollars in cost. More important, however, must be the realization that difficult as the engineering problems are, they are still vastly easier to solve than the collateral issues. In this extensive Ohio Valley alone over 17 million people reside. They engage in every form of enterprise from agriculture to manufacturing.

The technical solutions and resulting structures in one state have profound effects on one or more adjacent or lower states. In construction, financing, administration, and legislation a remarkable degree of intellectual "tight-rope" walking is required to determine who is to pay for what, who is assessed in one area to create the beneficent effects in another area, who is to administer completed undertakings, and what shall be the conditions governing such administration.

The handling of a single resource in this typical basin of the United States dramatizes at once the issues of local versus central financing and administration. Moreover, when the collateral undertakings—in land use, involving soil erosion control and forestation; in power, involving navigation, water supply, and disposal of wastes; and in other related fields—intrude into the picture, the confusion of governmental agencies, of divisions of responsibility, of assessments of benefits and damages, of overlying responsibility for operation during periods of flood crests and during drought, all these rise up to plague those simple minds who cling either to states' rights or to federalism and then retire peacefully to slumber. But more adequate answers involving engineering analysis and conscious translation of complex data into workable social formulas must be provided by those most competent to lead us out of these administrative wildernesses.

Reverse Problem—Too Little Water.~Another example of engineering and administrative territory of high risk is the difficulty with dust and drought on the Great Plains. Here again the problems and solutions are technical in character. They involve the engineer, the lawyer, the administrator, the financier, and the teacher. Rules for action so as to produce the most helpful result are in many instances lacking. Integration and coordination of the various units and levels of government involve highly complex difficulties. While in the Ohio Basin the control and use of too much water at one time and too little at another posed certain issues, in the Great Plains area far too little water for long periods of years is the clue to the difficulty. We must some day attempt to reconcile the desires, prejudices, and greed of local groups of our country's population to the best advantage of all.

In this new kind of pioneering—pioneering in integration of effort rather than the simple geographical type with which we are all familiar—the engineer and scientist must take the lead. The adaptation of our natural resources and of our familiar structural machinery of government to new or more complex problems appears to offer an important, fruitful, and challenging field for the scientist of tomorrow. Upon the engineering schools rests the great responsibility of so preparing the intellectual ground of its graduates that they will meet these issues with courage, honesty, and ability. These seats of learning must see to it that in their distribution of the tools of knowledge they provide their graduates with the technique and attitude necessary to sustain our cherished liberty by orderly processes of government and of law.

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Volume 7

CIVIL
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June 1937

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The Mississippi Meets the 1937 Flood

Jadwin Plan Levees and Recent Cutoffs Function Perfectly Under Severe Test

By George R. Clemens
Member American Society of Civil Engineers
Senior Engineer, Mississippi River Commission, Vicksburg, Miss.

By the time the Ohio flood of last January had reached the Mississippi River, the country was well-nigh convinced that "another 1927" was in the offing. Excitedly, people from coast to coast watched the alarming headlines. Then one day the flood stories moved to the second page. Something had happened; the wild predictions had failed to materialize.

During the whole period the engineers who have the river in their charge were probably the least excited people in the country. They were confident—confident that their work of the last eight years had put Old Man River in shape to withstand just such a flood as it was experiencing.

From his position of vantage as principal assistant to Maj. R. D. Burdick in charge of all emergency work at Cairo, and from his later observation on the lower river, Mr. Clemens was in an unusual position to note the facts here recorded. In addition to giving his observations extending from the hurried opening of the New Madrid floodway for the purpose of relieving Cairo, to the placing of the last needle back in position on the Bonnet Carré spillway, he reviews briefly the general principles of present-day Mississippi River flood control, and the effect of the man-made cutoffs on reduction of crest stages. This article is abstracted from a speech delivered at the annual meeting of the Mid-South Section in Memphis on April 16, 1937.

•

Towards the end of January 1937 an angry flood, fresh from triumphs of destruction in the Ohio Valley, rushed forth to meet Old Man River. It roared and railed at him, made a mighty effort to destroy his protective works, and finally, beaten, dropped its tail between its legs and scurried off to the Gulf—the forgotten flood.

The well-nigh perfect functioning of the levee system, the floodways, and the cutoffs was a thorough justification of the protective methods now employed on the Mississippi River. A brief review of their principal features may serve to orient the reader for what follows.

PROVIDING AGAINST EXPECTED FLOODS

It is scarcely necessary to describe here in detail, however, the so-called Jadwin plan of flood protection (Fig. 1), which was adopted in 1928. Except for the Boeuf Basin work and the Atchafalaya levees, this plan was essentially completed by the end of 1936. (In 1936 a modified plan was approved by Congress called the Markham Plan, which substituted a Macon floodway for the Boeuf, a Morganza floodway for the East Atchafalaya, added an outlet for the Atchafalaya west of Morgan City, and included plans for flood protection of the St. Francis and Yazoo tributary areas and the White River backwater. Practically no construction work under this modified plan had been completed up to January 1937.)

In June 1932 Brig. Gen. Harley B. Ferguson was detailed as president of the Mississippi River Commission. General Ferguson had studied the Mississippi River for years and was convinced that there was a great opportunity to improve the river by following a very simple principle that we have been inclined to overlook—water will run downhill if given a reasonable chance. On its face such a statement seems so simple as to be absurd, but careful analysis shows that we have been doing many things that prevent the river from doing just that. In a measure, levees, dikes, and revetments all prevent a river from running downhill in an unobstructed manner. Revetments, at least in some cases, actually reduce the flood-carrying capacity of the river by de-

© Detroit News Airphoto

The "Island" of Cairo, Ill., on January 26, 1937, from the Air
Ohio River at Right, Mississippi at Left and in Foreground

CC Company Building Bulkhead on Cairo Drainage District Levee
Looking Towards the Ohio River, February 5, 1937

creasing its cross-section at bank-full stage; levees admittedly raise stages by confining the flow to a part of the former flood channel; dikes built to prevent flow across the necks of bends hold up the water at the upper side.

With these facts and many others in mind, a definite policy of giving the river a reasonable chance to run downhill—in more scientific language, a policy of "channel improvement"—was established. The act of 1928 contained sufficient authority to carry out this work, and a program of cutoffs and channel improvement was undertaken from the Arkansas River to the Red, together with certain other work of channel enlargement and extension throughout the Atchafalaya Basin. The cutoffs shown in Fig. 1 are completed, but are not all fully developed, and have shortened the Mississippi by about 100 miles.

The channel improvement work has not been limited to cutoffs. Generally speaking, it is known that the most stable reaches of river are those of about average cross-sectional area at low, medium, and bank-full stages, and where the corresponding width is also average. An ideal river would be one of gradually curving alignment with a uniform cross-section and width. Taking these as principles and using the water surface slope as the means of determining unsatisfactory reaches, dredging and bank construction have been undertaken at many localities. This work cannot be laid out in detail in advance but must follow the river's movements. As one sore place turns up with an excessive slope, it must be analyzed and an attempt made to cure it. The river is a live, moving, changing thing and must be treated as a living patient, not a dead, inanimate block of rock where an inscription once carved remains for eternity.

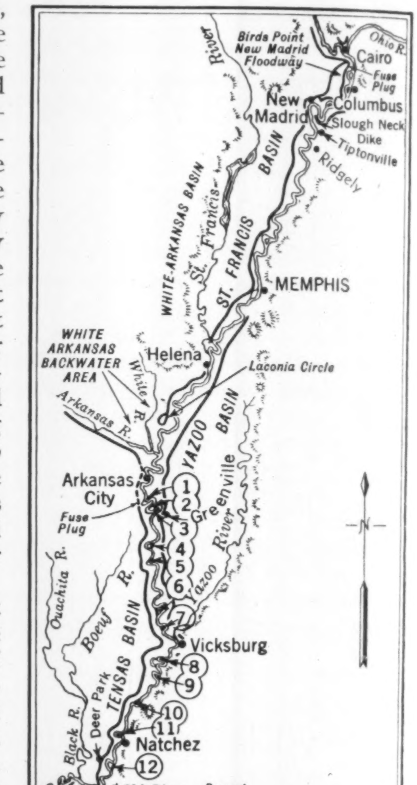
CAIRO PRESENTS CRITICAL SITUATION

Cairo, Ill., a city of about 15,000 people, is located at the junction of the Ohio and the Mississippi rivers. These two streams form the two sides of an isosceles triangle with the hills to the north forming the base. The city is protected by a combination of concrete wall and levee. Between Cairo and the hills is a leveed area called the Cairo Drainage District covering the remainder of the triangle, except for a narrow area at the base where the Cache River cuts between Cairo and the hills, which at time of high water makes the city of Cairo and the Drainage District combined, literally an island. Between the District and the city is a second line of defense which may be closed in event the Drainage District is overflowed.

Under the Flood Control Act of May 1928, the wall and levee surrounding Cairo had been reinforced and raised to furnish protection for an estimated stage of 60 ft on the Cairo gage. The actual height of the wall ranged from 10 to 25 ft. Opposite Cairo, in Missouri, the New Madrid floodway had been constructed to be opened in times of extreme flood to draw down excessive flood heights at Cairo.

With this general picture in mind, we may begin the story of those eventful weeks of February 1937, when the entire protective system was put to its first real test. On Thursday, January 21, it was apparent that a major flood would be experienced at Cairo, and warnings were sent out to evacuate the New Madrid floodway. Saturday morning it appeared that the floodway would be in operation very shortly. By Sunday afternoon the stage passed above 57 ft —which meant it was already higher than any ever before recorded—and rain was still falling on the upper Ohio River, with gage heights at points above Cincinnati higher than ever before recorded.

Under the project the fuse-plug levee at the upper end of the spillway was to have been cut down to function at a stage of 55 ft on the Cairo gage, but this had not been done, pending the settlement of a few remaining right-of-way cases. On Sunday evening, orders were issued from the District headquarters at Memphis to blast the fuse plug and permit overflow into the area as soon as possible. A dynamiting expedition was organized under the direction of Maj. R. D. Burdick, and by the next night three large crevasses were opened. Together with a number of natural crevasses that had formed a few hours earlier, they sufficed to draw down the stage at Cairo to the point where emergency bulkheads on the Cairo wall were able to protect the city from overflow. A total of approximately ten tons of dynamite was used, and crevasses totaling approximately 1,000 lin ft were opened.


Birds Point
New Madrid
Floodway
Ohio R.
Cairo
Fuse Plug
River
New Madrid
Columbus
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Ridgely
BASIN
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MEMPHIS
WHITE ARKANSAS BACKWATER AREA
Helena
White R.
Laconia Circle
Arkansas R.
YAZOO BASIN
Arkansas City
Fuse Plug
1
2
Greenville
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4
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Yazoo River
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Vicksburg
8
9
Ouachita R.
Boeuf R.
TENSAS BASIN
Deer Park
Black R.
10
11
Natchez
12
Red R.
Old River
Fuse Plugs
Bonnet Carre Spillway (Controlled)
Scale in Miles
0
50
N
BATON ROUGE
Lake Pontchartrain
NEW ORLEANS
Atchafalaya Floodway
ATCHAFALAYA BASIN
Grand Lake
GULF OF MEXICO

Fig. 1. Mississippi Levees, Floodways, Spillways, and Cutoffs as of January 1937

Location of Cutoffs Shown by Numbered Arrows

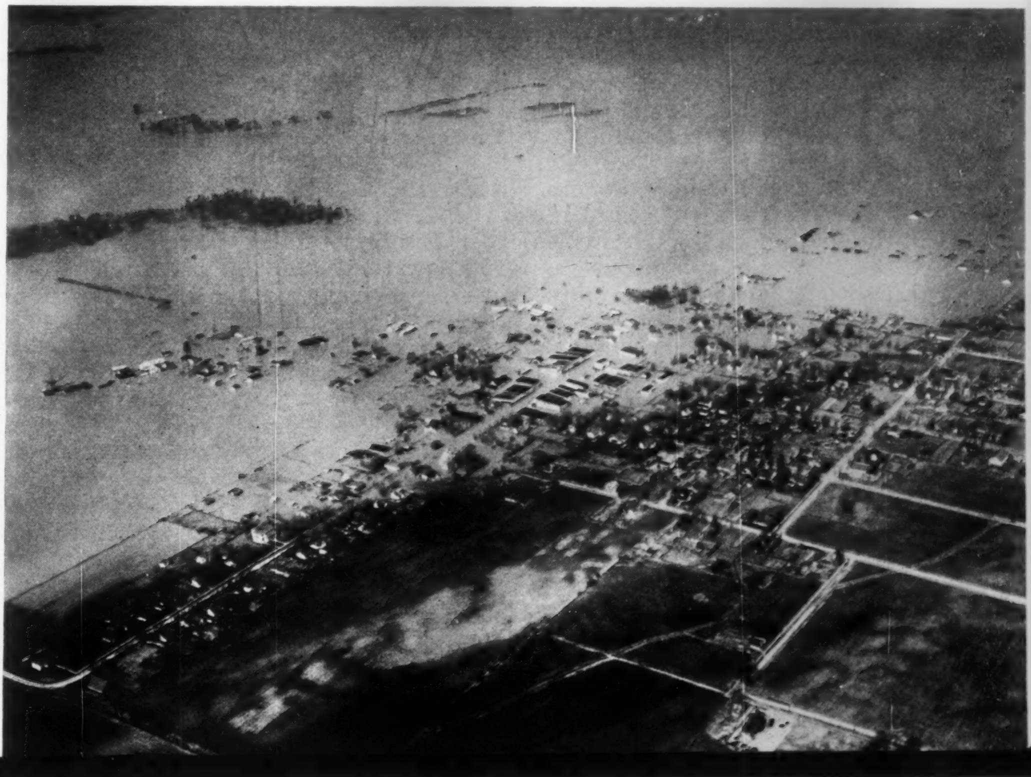
Concurrently, a bulkhead was built on the Cairo sea wall. A considerable section of the sea wall was of a cellular-type construction, consisting of two sections of concrete wall with earth fill between. This made an ideal condition for bulkhead construction. Stakes were driven behind the outer wall and boards run between them, with a second row of stakes about 18 in. behind the first row, likewise boarded between, forming a box on the earth section of the wall. Inclined braces were run from the box to the rear concrete wall. Railroad tracks parallel a considerable part of the wall, so that dirt could be brought in cars to fill the box and also to fill sand bags, which were placed in front of the box for protection from wave wash and seepage. Sand bags were also placed behind the box for reinforcement and to prevent seepage. In this manner a very rigid emergency structure was built which increased the height of the sea wall by approximately 3 ft. At the crest of the flood as much as 9 in. of water above the top of the old wall was held out of the city by this means.

FIGHTING SAND BOILS WITHIN THE CITY

For many years Cairo has been affected at all times of high water by sand boils within the city area. During the early part of the 1937 high water these did not appear in as great numbers as in the past. However, as the stage increased to its maximum of approximately 3 ft over any previous record, a considerable number of boils developed. Generally speaking these were not serious. One, however, reached considerable proportions before it was brought under control. It broke out near the main collecting sewer a short distance from one of the pumps, which had to be kept running to prevent seep water and sewage from accumulating in the city (the street level at the time being approximately 18 to 20 ft below the water surface in the river). At first the boil behaved like many others, throwing out a ring and considerable muddy water. Shortly thereafter it disappeared from view, and it was not until large sections of the street and several nearby buildings had sagged or fallen down that it was apparent what had occurred. The boil had broken into the main sewer, and with the drainage pump had formed a perfect dredge, pumping out considerable yardage from beneath one of Cairo's main streets.

Thus a rather interesting problem was presented as to how to stop enlargement of this boil and at the same time permit the pumps to continue disposing of seep water and sewage. A solution was finally worked out by bulkheading off from the pumping system of the city a section of the main sewer about 1,000 ft long, isolating within this reach the area affected by the boil. The bulkheads had to be constructed under a head of about 10 ft of water in a concrete sewer about 6 ft in diameter by a diver placing sacks of dry-mix concrete, using quick-setting cement, against a framework of drill rods driven through the sewer from the street above. On completion of these bulkheads the boil was brought under control.

In the drainage district north of Cairo a bulkhead was constructed on top of the earth levee and a maximum of slightly over one foot of water over the top of the levee was held out of the area. In all, some 8 miles of emergency bulkhead were constructed, and although high stages prevailed for approximately one month, no serious difficulties were experienced other than those described.



The Ohio Flood at Ridgely, Tenn., on February 12, 1937

Thus the Mississippi River met the first thrust of the 1937 flood. Cairo was the only dry city in the Ohio basin. The New Madrid floodway functioned essentially as planned, and protected not only Cairo but the entire St. Francis basin from a flood that most certainly would have overtopped the levees as they stood in 1927. At the crest, about 2,000,000 cu ft per sec passed Cairo, and about 500,000 cu ft per sec was carried in the floodway.

SUCCESS ATTENDS EFFORTS ELSEWHERE

Immediately below Cairo the flood was somewhat tamed but still a little difficult to control. At Slough Neck a dike extending at right angles to the river broke at Bessie Landing and added to the depth of overflow of some unprotected land, but the town of Tiptonville, below the neck, remained above overflow although in the midst of the Mississippi Valley and unprotected by levees.

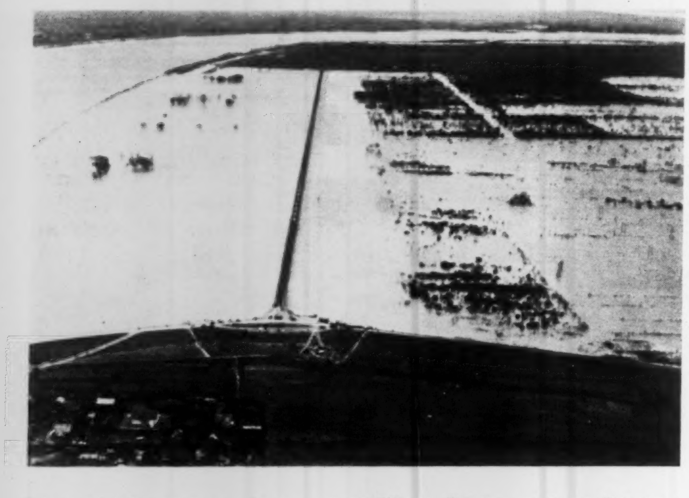
Below Tiptonville the flood began to feel the straight jacket of Old Man River. It continued to work its vengeance on some unprotected places such as Ridgley, Tenn., but generally subsided to orderly flow towards the Gulf. At Memphis it backed up into unprotected corners, but its flow line was at all points below the grade line prepared for its reception and well below the tops of the levees constructed under the act of 1928. Here and there sand boils gave some concern and kept the flood fighters active, but at no place was the security of the levees endangered.

Below Helena, at Mellwood and Ferguson, Ark., the flood-fighting force had a rather serious situation to deal with. Late in 1936, excessive settlement had lowered some 3,000 ft of levee to a point where it would have been topped by a stage of about 52 ft on the Helena gage. A bulkhead was started along this stretch early in the flood fight, and kept well above the rising water. Eventually the stage at Helena exceeded 60 ft, but no further levee settlement occurred, and the bulkhead held.

From Cairo to Helena, stages at all points exceeded the previous record highs of both 1913 and 1927. Between Helena and Arkansas City the stage-lowering effect of cutoffs in the lower river became apparent, and from Arkansas City to Old River stages were materially reduced by the channel improvement work.

Another factor that helped the flood fight on the lower river was the relatively good behavior of the White and the Arkansas rivers. There was an early flood on the White but it was largely out of the way (helped of course by the improved channel) before the main flood reached Arkansas City. The Arkansas contributed a moderate amount of flow but considerably less than in 1927.

One of the questions most frequently asked regarding the 1937 flood is: What was the effect of the cutoffs and channel improvement work? The complete answer is too complicated to give in a few words, but certain facts may be stated briefly.



LOOKING UPSTREAM ALONG THE WEIR STRUCTURE OF BONNET CARRÉ SPILLWAY ON FEBRUARY 7, 1937

Mississippi River at Left and in Distance; Discharge About 80,000 Cu Ft per Sec

CUTOFFS PROVE EFFECTIVE

For a number of years discharge measurements have been made near Arkansas City. Careful records have been kept of previous flows and gage heights, and plots made so that old records could be readily compared with new information. As the 1937 flood developed, daily measurements of the flow at this and other key stations were made and wired to the Mississippi River Commission office. Reports for the rising branch of the rating curve of the 1937 flood showed that for stages above 45 ft, the discharge ranged from 500,000 to 700,000 cu ft per sec in excess of that carried at the same stages in 1929.

At the crest, a flow of approximately 2,150,000 cu ft per sec was carried at a stage of 54 ft. In 1929, only about 1,450,000 cu ft per sec was carried at this height during the rising stage, and 1,350,000 during the falling stage. It is estimated that without the draw-down resulting from the improved channel, the 1937 flood would have exceeded the grade line of the so-called fuse-plug levee near Arkansas City.

Throughout the Vicksburg District the lowering of the flood plane was considerable. There are now three cutoffs through the Greenville Bends. Even below them, the 1937 crest was about one foot below that of 1929, although the flow was fully 20 per cent greater. At Vicksburg (the lower end of the District) the rising branch of the rating curve showed an improvement in carrying capacity since 1929 of roughly 370,000 cu ft per sec for stages above 45 ft.

The flood fight from Arkansas City to Vicksburg was a very tame affair, consisting mainly of watching for boils and seeps. A small amount of topping was done to increase freeboard. As a result the minimum freeboard in the District was 6 ft at the crest of the flood, ranging up to 12 ft throughout a considerable part of the area.

IN THE LOWER RIVER AND ATCHAFALAYA

As the flood arrived in the lower reaches of the river it found improved outlets to speed its path to the Gulf. Although its peak rate of discharge exceeded that at which, under the Jadwin Plan, it would be permitted to overflow into the Atchafalaya floodways or the Red River backwater area, it was actually confined within the main levees without using either of these emergency provisions. To make this possible it was necessary to raise slightly the section of levee below Deer Park that had been purposely left low. In places more than one foot of water was carried above the old levee crown elevation. The stage at Natchez exceeded that of 1927 by only one foot, which showed that even at that point the channel capacity had been increased. At Angola a number of factors combined to produce a stage about 2 ft below that of 1927.

The Atchafalaya River at Simmesport carried nearly 500,000 cu ft per sec, approximately the same flow as that prior to the formation of crevasses in 1927, at a stage 4 ft lower than the 1927 crest. No crevasses occurred in the Atchafalaya levees in 1937.

It early became apparent that there was sufficient water on the way down the river to raise the stage at New Orleans above 20 ft. Since the Bonnet Carré spillway had been constructed to prevent such an occurrence, it was decided to put it in operation in advance. A few bays were opened and the water was permitted to flow over the sills as the river rose. With water against the needles, successive bays were opened in the days following, until 285 of the total 350 bays were in use. At the crest of the flood the discharge through the floodway was about 80 per cent of its capacity, or approximately 210,000 cu ft per sec. By this action the stage at New Orleans was held to 19.3 ft. It is estimated that without the relief afforded by the spillway it would have reached a maximum of 22 ft.

One of the interesting features of the operation of the spillway was the ease with which the needle gates were operated. The operating crew developed a technique of handling the needles whereby they were able to replace one bay in approximately 10 minutes. When the flood began to subside, the spillway was closed in such manner as to prevent increasing

DIVER ABOUT TO PLACE CONCRETE BULKHEAD IN MAIN 6-FT SEWER TO STOP SAND BOIL AT CAIRO, ILL.

stages at New Orleans, but at the same time to discontinue the use of the floodway as rapidly as possible. The last bays were closed on March 17, 1937.

Aside from raising the levee below Deer Park and operating the Bonnet Carré spillway, most of the flood fight in the New Orleans District was watching for boils and seeps and organizing for normal high-water maintenance. Low spots in the levees at the head of the Atchafalaya floodways were brought up sufficiently to protect against the expected rise, and preparations were made for holding these fuse-plug levees against higher water without endangering the main river levees below Old River. Although a break or overtopping of the fuse plugs was not expected, the town of Simmesport was given protection by a low ring levee; some gaps in the guide levees were closed and preparations made to close the remainder; and an emergency levee was constructed from Viva to Morganza to give protection to the Plaquemine area. The normal protection against wave wash was carried out where needed in the District.

A comparison between the floods of 1929 and 1937 is given in Table I. It should be noted that for all points above the mouth of the White River the 1937 flood established record heights. Below this point, only at Natchez was the previous record height exceeded.

Hickman, Ky., During Flood, on February 12, 1937

This was the flood that caused disaster in the Ohio Valley, filled the front pages of all our newspapers while it was developing, sweeping through the lower Ohio Valley, and approaching Cairo. But as it passed Cairo it dimmed in the public eye and was carried to the Gulf of Mexico by Old Man River, scarcely noticed by those not living in the lower alluvial valley. Such, in brief, was the outstanding success of the protection work along the Mississippi itself.

SATISFACTION, IN RETROSPECT

As doctors sometimes grow to think that everyone is sick or complaining, and lawyers feel that everyone is dishonest or in trouble, we as engineers occasionally feel that no plan or project functions satisfactorily. There is always some little thing wrong which we magnify to the point of condemning a whole project. We become so involved in details that the failure of some small item to justify our expectations causes us to throw up our hands in alarm. Although we must watch the trees, let us not lose sight of the forest.

The 1937 flood was a major disaster in the Ohio Valley and a great flood in the lower Mississippi. Now that it has subsided and we can review it calmly, let us catalog it where it belongs—basing our statements, as engineers should, on facts. This was not a "super flood." It was at least 20 per cent less than the so-called Jadwin super flood in crest rate of flow from Cairo to Helena. Below the Arkansas River it lacked almost one-third of reaching the crest flow provided for by the Jadwin or Markham plans. Yet in the lower river below the Arkansas, we had the experience of carrying between levees a flood well over 2,000,000 cu ft per sec. Perhaps we have not diagnosed each sick place correctly, or cured the old river of all his ills, but at least his constitution has been built up to the point where he could easily throw off the 1937 flood.

It is surprising that there should have been so much hysteria as the flood approached the lower Mississippi Valley. The country had enough confidence in the engineers to give them over $300,000,000 for the Mississippi River flood plan. Why then did people become unstrung when the floods descended upon that plan? Now that the flood has subsided it is clear that the plan worked about as expected—and that the flood was considerably less than the protection provided against it. If the men who know and love Old Man River can now have an opportunity to sew up the wounds caused by the 1937 flood and build up those vital organs which were a little weak—if that is done, I am confident the next flood will be held within bounds as was this one.

Table I. Comparison of 1929 and 1937 Floods on the Mississippi River

(Flows Are Given in Cubic Feet per Second; All 1937 Figures Subject to Revision)

Place*	May–June 1929		January–February 1937	
	Stage	Flow	Stage	Flow
Upper Mississippi River				
Cape Girardeau, Mo.	37.4	745,000	27.6	172,000
Ohio River				
Cairo, Ill.	52.7	854,000	59.6	1,950,000
Lower Mississippi River				
Columbus, Ky.	49.3	1,632,000	53.6	....
Tiptonville, Tenn.	..	....	..	2,010,000
Memphis, Tenn.	41.5	1,600,000	50.4	2,020,000
Helena, Ark.	52.6	1,581,000	60.3	1,970,000
Arkansas City, Ark.	58.8	1,788,000	53.8	2,160,000
Vicksburg, Miss.	55.2	1,741,000	55.5	2,060,000
Natchez, Miss.	54.5	....	58.0	2,046,000
Angola, La.	52.4	1,250,000*	55.5	1,467,000
Carrollton, La.	20.0	1,242,000	19.3†	1,250,000 to 1,340,000‡
Atchafalaya River				
Simmesport, La.	46.4	385,000	49.3	470,800

* Approximate.
† Peak stage as reduced by operation of Bonnet Carré spillway.
‡ Variable.

Reaction-Time and Traffic Behavior

Tests Reveal Importance of Personal Characteristics in Driving a Motor Vehicle

By Bruce D. Greenshields
Associate Member American Society of Civil Engineers
Professor of Engineering Science, Denison University, Granville, Ohio

Although roads were wider and straighter in 1935 than in 1929, and cars less numerous as well as more powerful and easier to control, nevertheless 5,242 more fatal accidents occurred. The bearing of traffic behavior, and in particular of the driver's reaction-time, on the question must thus be taken into account. A means for reducing the time of reaction is probably more important in highway design than in safety work, since traffic would thereby be speeded up and road capacity increased, whereas it has not been demonstrated that reducing reaction-time would lessen accidents. But before means for reduction can be planned, much study of this variable factor is required. In the following interesting article, Dr. Greenshields summarizes the results of several investigations already made in various parts of the country, dealing with the relations between reaction-time on the one hand and vehicle spacing and driving ability on the other. Laboratory tests to determine the average duration of reaction-time are also described in some detail.

The modern automobile is marvelously easy to control, responding to the slightest action of the driver with a burst of speed or a quick stop. But it is not a complete automatism in itself; it cannot, like the faithful horse, react to its surroundings. The driver must see the curve ahead and turn the wheel, feel the roughness of the road and lessen the pressure of his foot on the accelerator, or hear the policeman's whistle and bring the brakes into action. The brief interval between the happening of something in one's environment and the time when a certain response is made to it is called "reaction-time." This interval may be, for example, that between the time a pedestrian steps into the street and the time the steering wheel is turned to avoid him.

In general, the speed of all forms of reaction varies from one person to another and from time to time in the same person. It changes gradually with age, very young and very old people being slower in their reactions. The reaction to hearing is quicker than to seeing. A person is more certain to react to a strong stimulus than to a weak one, although by straining he may be able to react more quickly to the weak stimulus ("Reaction-Time Measurements," by H. M. Johnson, in *Psychological Bulletin*, Vol. 20, 1923, pages 563–587). The stimulus, of course, may be so weak as to cause no reaction at all. Extreme fatigue decreases the ability to respond. The effect of alcohol varies with the individual—it does not necessarily lengthen reaction-time, but an excess amount makes the reaction-time more uncertain. All of these statements except the first might be open to question, but the first is of paramount importance in considering traffic behavior.

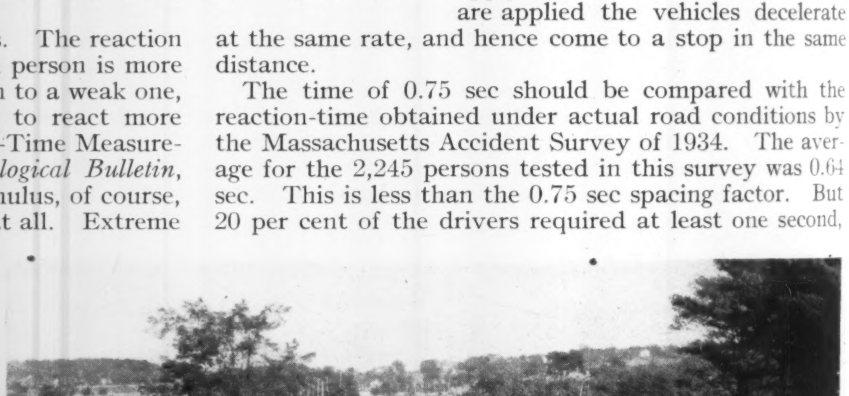
In a moving automobile, the driver must always react in the time and space available. Failure to do so accounts for the appalling number of accidents and deaths that occur on our highways every day. The higher the speed, the more important become time and space, those basic factors of highway safety.

REACTION-TIME AND SPACING

While making some traffic studies in Michigan in 1933, I first became interested in reaction-time as a factor in automobile driving. It was observed that in a queue of vehicles there tends to be a certain minimum spacing, which at two or three miles an hour averages about 5 or 6 ft. At greater speeds the spacing is increased by an amount equal to 0.75 times the speed in feet per second. That is, $S = 6 + 0.75V$, where S is the spacing in feet, and V is feet per second. Perhaps because of distractions, drivers in city traffic allow themselves about 0.95 sec to react ("Studying Traffic Capacity by New Methods," by Bruce D. Greenshields, Civil Engineering for May 1935).

The equation means that the variation in the minimum spacing depends entirely upon the factor 0.75. This is about the average time in seconds that it takes a driver to bring his brakes into operation when the occasion arises. Two vehicles with equally good brakes, traveling at the same speed, will not collide if the driver in the rear car has time to apply the brakes. After the brakes are applied the vehicles decelerate at the same rate, and hence come to a stop in the same distance.

The time of 0.75 sec should be compared with the reaction-time obtained under actual road conditions by the Massachusetts Accident Survey of 1934. The average for the 2,245 persons tested in this survey was 0.64 sec. This is less than the 0.75 sec spacing factor. But 20 per cent of the drivers required at least one second,



View on the Worcester Turnpike in Massachusetts
In Crowded Traffic, Vehicles Maintain Spacings Which Depend Upon Their Speeds and the Reaction-Times of the Individual Drivers

and 5 per cent more than one second. Obviously, for safety a person must allow for his longest reaction-time rather than for his average.

Reaction-time is an essential consideration for the highway engineer. If it can be reduced by a more convenient location of the brake and accelerator pedals, or by the innovation of a hand control (for the hand is quicker than the foot), vehicles will travel with shorter spaces between them, traffic will be accelerated, and an economic saving will be effected. But let us not draw conclusions too quickly.

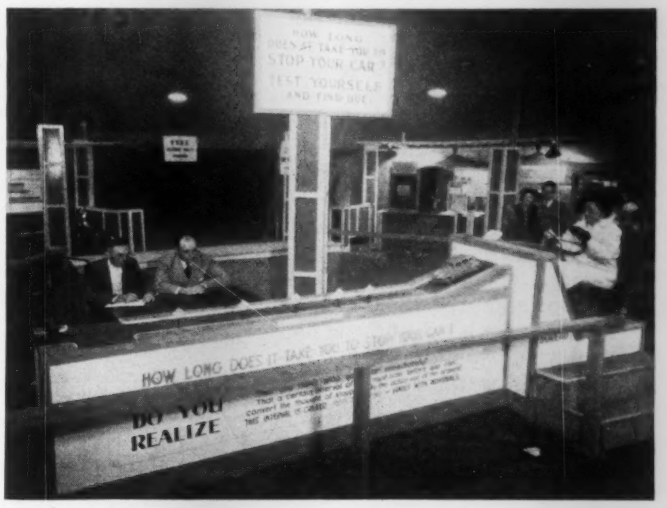
In the summer of 1934, the traffic bureau of the Ohio State Highway Department took observations of the movement of traffic in order to secure a measure of highway capacity. In this study it was revealed that the average driver allows himself 10 to 11 sec and 1,000 to 1,500 ft for passing ("Distance and Time Required to Overtake and Pass Cars," by Bruce D. Greenshields, *Proceedings, Fifteenth Annual Meeting of the Highway Research Board*, pages 332–342). The driver's reaction-time must be included in this 10 sec. Thus the person with a reaction-time of 0.5 sec has an advantage over the person who takes one second to act, but if he allows himself one-half second less time for passing, he has no greater margin of safety.

A more recent study conducted in Ohio for determining the point at which crowding commences to cause interference has furnished some additional information on reaction-time. This investigation indicated that vehicles closer together than a spacing of 31 to 40 ft (center to center of car) are usually in the act of passing. The maximum average variation in speeds was found to be a little over nine miles per hour. This occurs at a spacing of approximately 200 ft, the point at which drivers react to the presence of the car ahead and make ready either to slow down to the same speed or to pass. Undoubtedly this point is related in some way to reaction-time.

LABORATORY TESTS OF REACTION-TIME

The laboratory type of test has also furnished valuable facts concerning automobile driving and reaction-time. The safety division of the traffic bureau, Ohio State Highway Department, designed and constructed, for measuring brake reaction-time, apparatus which was exhibited at the Ohio state fair in August 1935 and in the fall of the same year at the Columbus automobile show. The results of the tests made on this apparatus disclosed that brake reaction-time varies with the distance the foot has to travel from the accelerator to the brake pedal. Racetrack drivers and others who keep the left foot in contact with the brake pedal were found to react most quickly. The average time for these drivers was 0.294 sec, while the average for those who drive in the usual way was 0.496 sec.

The apparatus, shown in one of the photographs, consisted essentially of the facsimile of the front of an automobile, a short miniature roadway containing an intersection with a traffic light, a toy automobile which ran on the road, and a chronoscope (stop watch) reading to 0.01 sec. In taking the test to determine his reaction time, the subject sat facing the miniature traffic light on the roadway. He was instructed to depress the accelerator, whereupon the green light in the traffic signal came on and a bell started to ring. This assured the observer that the person taking the test had the accelerator down and that he was ready to react to the flashing of the red light in the traffic signal.


HOW LONG DOES IT TAKE YOU TO STOP YOUR CAR?
TEST YOURSELF AND FIND OUT
HOW LONG DOES IT TAKE YOU TO
DO YOU REALIZE

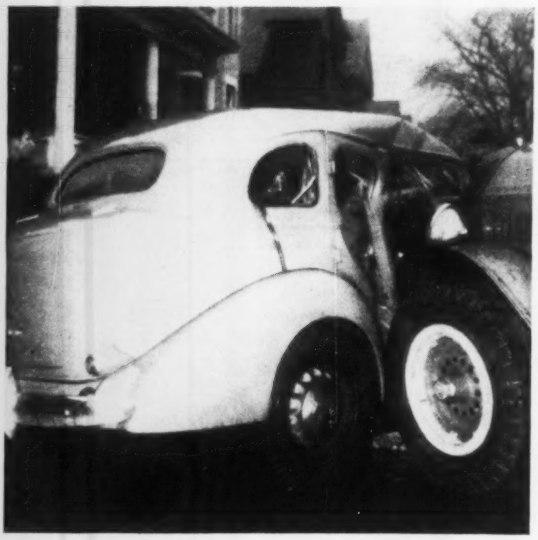
Apparatus for Measuring Brake Reaction-Time, Designed and Constructed by the Traffic Bureau of the Ohio State Highway Department

Dr. H. R. De Silva

Latest Model of a Reaction-Time Outfit

After the subject had had his foot on the accelerator for 2 sec or longer, to allow him to get ready, the test supervisor pressed a button which simultaneously changed the traffic light from green to red, started the stop watch, and released the toy car at the top of the small incline so that it started to roll down the roadway toward the traffic signal. Seeing the red light, the person taking the test removed his foot from the accelerator as quickly as possible and depressed the brake. This action broke electrical circuits, stopped the chronoscope, and turned off the traffic light, while a center strip in the road rose and stopped the toy car. The place where the miniature car stopped showed the approximate reaction-time for the benefit of the spectators. The reaction-time was then read and recorded. When the car was replaced at the top of the incline, all was in readiness for another test. The toy car helped to attract attention to the apparatus.

Although 1,461 people took the test, only 284 filled out questionnaires giving their accident records. Of this number, 4 admitted having been involved in accidents causing fatal injuries, 70 in accidents involving personal injury, and 13 in accidents not involving personal injury. There were 145 who reported no accidents over a period of five years, and 52 who furnished no information. The fact that approximately one-third admitted being involved in accidents indicates that it is possible to secure records of driving experience by the use of a questionnaire. While the tests of those furnishing accident records were too few in number to give definite proof,



INSUFFICIENT TIME FOR REACTING CAUSED THIS ACCIDENT

Photo of Truck-Passenger Car Crash Supplied by Bureau of Accident Prevention, Division of Police, Columbus, Ohio

they indicate that slow reaction-time has little to do with accident proneness. The 87 persons with accident records had an average reaction-time of 0.477 sec, and the 145 with no accidents had an average reaction time of 0.476 sec ("Reaction-Time in Automobile Driving," by Bruce D. Greenshields, *Journal of Applied Psychology,* June 1936).

Tests on over 50,000 persons were made during 1934 by Frank R. Olmstead, accident research engineer of the Michigan State Highway Department. In these tests approximately 26,000 data cards were tabulated and the factors affecting reaction-time correlated. From the results of his study Mr. Olmstead concluded that accidents are in direct proportion to driving mileage, and that all motorists, regardless of their reaction-time, are equally subject to accidents. Those who react quickly are involved more frequently than those who react slowly. But the former drive more miles and at higher speeds, and are consequently exposed to more situations which may result in accidents ("A Study of Factors Influenced by Automobile Brake-Reaction Time," by Frank R. Olmstead, *Proceedings of the 22nd Annual Highway Conference,* Michigan State Highway Department, pages 16–27).

Tests made on a thousand drivers in Nova Scotia show that people with a slow reaction-time drive more slowly, as is indicated in Table I. This bears out the findings of Mr. Olmstead.

REACTION-TIME AND DRIVING ABILITY

The conclusion to be reached from these data is that reaction-time is not in itself a criterion of driving ability. The numerous reaction tests set up at automobile shows and state fairs and in various population centers during the last two or three years have attracted much attention, and no doubt they have a great deal of educational value. But until correlated with actual driving experience, such tests have little or no value as a measure of driving ability.

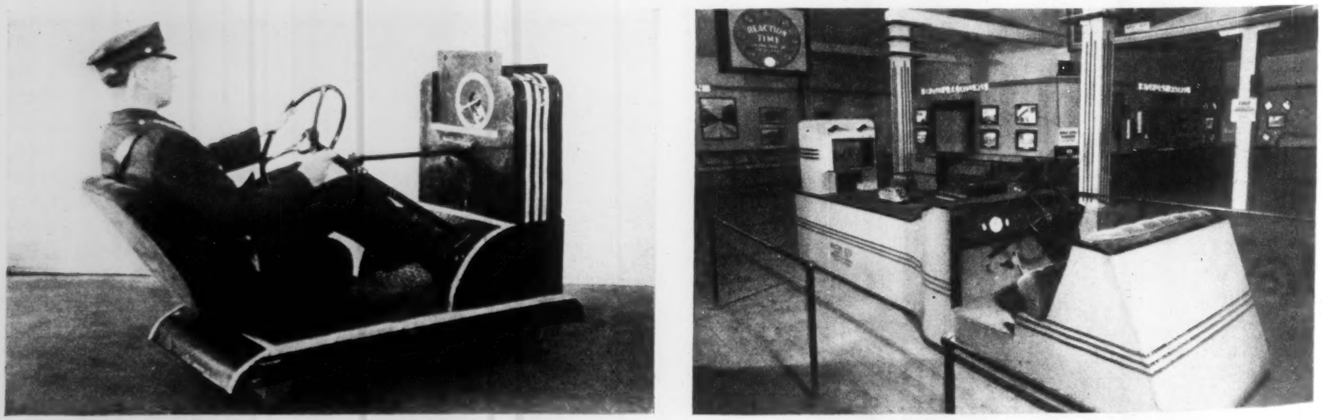
Dr. H. M. Johnson, research associate of the Highway Research Board, suspects that distractions play a part in driving, but not as a result of their lengthening of reaction-time. Apparently the good driver maps out a program of operation for some distance ahead, thus freeing himself from the necessity for making a quick decision and obtaining more time to react. Now if a back-seat driver disturbs his predetermined pattern, the driver must readjust himself. Dr. Johnson believes that it is this additional time required for readjustment which causes the disturbed driver to take longer to react. It is also true that emotions such as anger or fear interfere with the driver's reactions.

Accuracy in estimating one's own reaction-time is of prime importance. The slow-reacting driver who always makes ample allowance for his slowness is a safer driver than the quicker but more heedless person. The drunken driver is not more dangerous because his reactions are slowed but because they are more likely to stray from the normal.

From a mechanical standpoint the wide, straight roads and the powerful, smooth-riding, and easily controlled cars of today are safer than the older roads and the outmoded vehicles. But although 275,686 fewer cars were registered in 1935 than in 1929, there were 5,242 more deaths in 1935. This represents a decrease of 1.04 per cent in registration and an increase of 17.0 per cent in accidents, and illustrates the fact that while safety can be built into the highway and into the vehicle, the factor of traffic behavior must be taken into account.

TABLE I. RELATION BETWEEN REACTION-TIME AND ESTIMATED DRIVING SPEED

SPEED ON OPEN HIGHWAY, ESTIMATED BY DRIVERS In mph	NUMBER OF PERSONS TESTED	AVERAGE REACTION-TIME In sec
Under 30	48	0.539
31–35	304	0.529
36–40	384	0.519
41–45	177	0.517
45–60	98	0.518
51–60	19	0.507



Apparatus Used by American Automobile Association, Washington, D.C.

A New Model Devised by the Ohio State Highway Department

TWO RECENT TYPES OF APPARATUS FOR MEASURING REACTION–TIME

Planning the Lincoln Tunnel Under the Hudson

General Conception and Development of Vehicular Tube Connection to New York City

By O. H. Ammann

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Chief Engineer, the Port of New York Authority, New York, N.Y.

As vehicular traffic across the Hudson River between New Jersey and New York City and environs continues to grow by leaps and bounds, additional highway connections are becoming necessary. Traffic has actually risen from 5,000,000 vehicles annually in 1915 to 31,500,000 in 1936—an increase of over 500 per cent in 21 years. These multitudes of cars are all carried by one bridge, one tunnel, and 19 ferries. A further increase to 40,000,000 is anticipated by 1941, when the second tube of the Lincoln Tunnel is scheduled to be completed.

In the accompanying article Mr. Ammann describes the development of the Lincoln Tunnel project to its present form, and discusses the various considerations which determined its final location, the type and arrangement of exits and entrances, and the plan of approaches. This article constitutes the first of a series of three independent papers taking up in turn the general planning, design, and construction of the Lincoln Tunnel. It is abstracted from Mr. Ammann's address delivered December 16, 1936, before the Metropolitan Section of the Society.

Shortly after the Holland Tunnel had been opened to traffic in 1927, and while the George Washington Bridge was still under construction, it became evident that a third highway linking New Jersey and New York City across the Hudson River would soon become necessary. Traffic in the Holland Tunnel was increasing at a rate which meant that its capacity would soon be reached. In fact, serious peak-hour congestion in the adjacent streets had already occurred on a number of occasions. It was also realized that while the George Washington Bridge would relieve intolerable cross-river traffic conditions in upper Manhattan, it would not do much to relieve growing traffic in the midtown section.

The story of the fast-mounting vehicular traffic during the fifteen years before the depression is told in Fig. 1, which also brings out clearly the stimulating effect of new crossings. Between 1915 and 1920 the number of vehicles which crossed the river annually on the 19 ferries between the Battery at the southern tip of Manhattan, and Tarrytown, increased from 5,000,000 to 7,500,000. In 1925 about 12,500,000 vehicles crossed the river, and in 1930 about 26,000,000. Furthermore, the total trans-Hudson traffic continued to increase until in 1932 it had reached about 29 million vehicles. This increase took place in spite of the depression, which set in in 1929, but partially because of the traffic-generating effect of the opening of the George Washington Bridge in 1931. In 1933 vehicular traffic dropped slightly, but since 1934 it has been steadily increasing with the general revival of business, reaching about 31,500,000 by the end of 1936.

It is estimated that the first tube of the Lincoln Tunnel, scheduled for opening early in 1938, will create its own traffic within a short time. On account of its limited capacity, this single tube is not expected to carry more than 5 to 6 million vehicles initially. But after 1940, when the second tube is expected to be in operation, the traffic through the tunnel should increase to more than 10 million, and the total trans-Hudson traffic to about 40 million vehicles. Only a relatively small and temporary volume of this traffic is expected to be diverted from the Holland Tunnel, the George Washington Bridge, and the ferries.

Impressive as these figures may appear, they are small compared with the volume of vehicular traffic which crosses over the East River and the Harlem River. On a typical day in 1932, when about 260,000 vehicles moved into Manhattan, only 40,000 came from the west across the Hudson River. About 120,000 crossed the East River alone and 220,000 came from the east across the East River and the Harlem River, or $5^1/_2$ times the volume which came from the west. This undoubtedly reflects the retarding effect of the less adequate facilities which have existed for crossing the Hudson and is a clear illustration of the potentialities of new links and future traffic across it.

DEVELOPMENT OF LINCOLN TUNNEL PROJECT

In 1929 tentative studies for a midtown tunnel were made independently by the former New York and New Jersey Holland Tunnel commissions and by the Port of New York Authority, both leading to approximately the same location between Weehawken and the vicinity of 39th Street, Manhattan. The two state governments then decided to merge the tunnel commissions with the Port Authority, to turn the Holland Tunnel over to this body, and to authorize it to make preliminary studies for such a midtown tunnel, now named the Lincoln Tunnel, in honor of Abraham Lincoln. The sum of $400,000 was appropriated for these studies.

In 1931 the Port Authority made a favorable report, whereupon the state governments authorized the Authority to proceed with the financing and construction of the tunnel without further financial aid by the states. However, by the end of 1931, when the plans for the tunnel had been developed to a degree which would per-

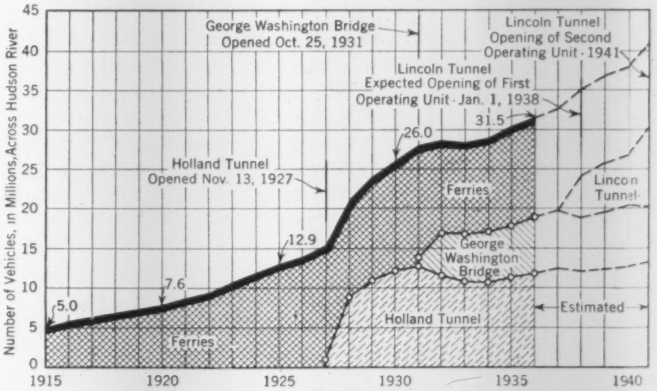


Fig. 1. Annual Volume of Vehicular Traffic Across the Hudson River, 1915–1936, with Estimates to 1941

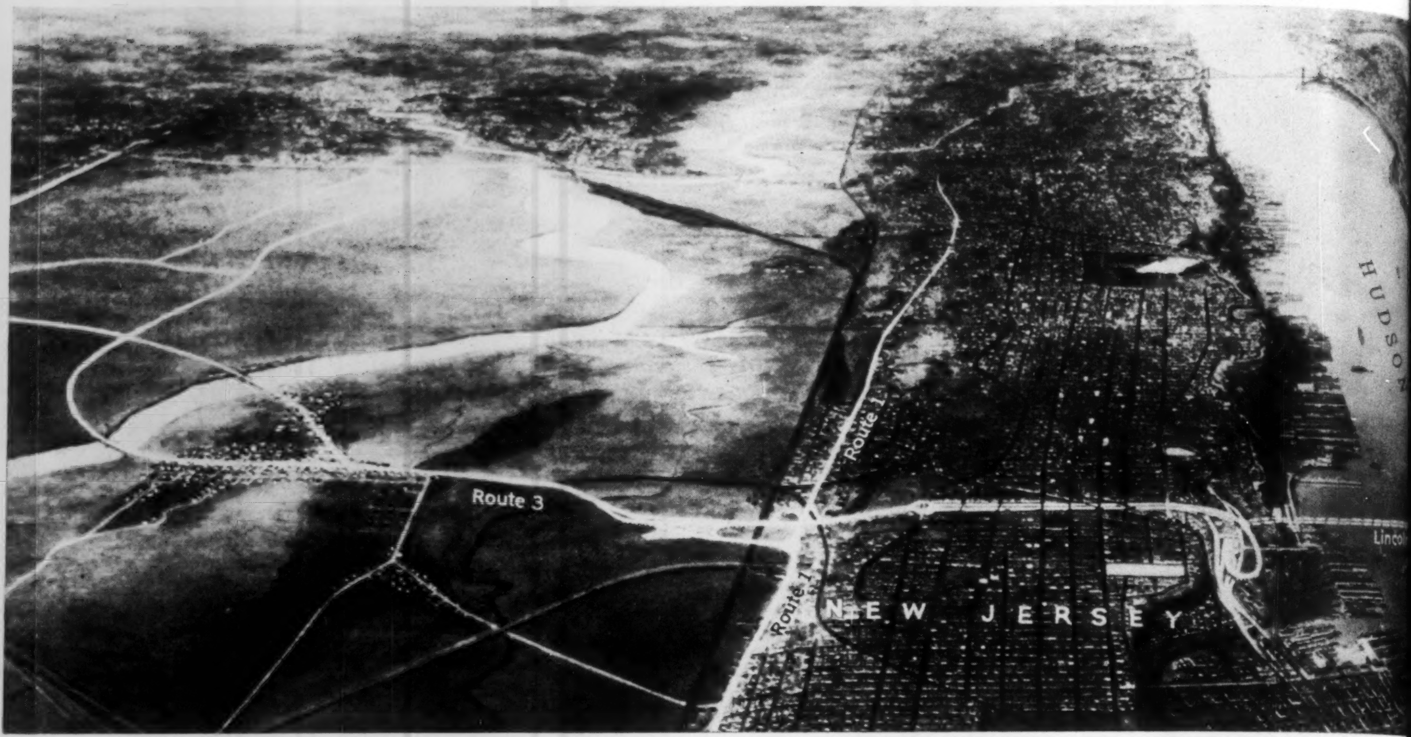


FIG. 2. GENERAL BIRD'S-EYE PERSPECTIVE OF NEW YORK CITY AND ADJACENT NEW JERSEY COMMUNITIES,

mit construction to start, the general economic situation made it impracticable for the Port Authority to sell its bonds, and the financing had to be deferred.

In the fall of 1932 Congress passed the Emergency Relief and Construction Act, under which the Federal Reconstruction Finance Corporation (RFC) was authorized to aid the financing of projects of a self-liquidating character. The Port Authority thereupon entered into negotiations with RFC for the advance of construction funds, and early in 1933 the Engineering Board of RFC recommended a loan of $75,000,000. But financing by RFC was not carried out, as its public works activities were transferred to the Federal Emergency Administration of Public Works (PWA).

In the meantime the Port Authority staff had made studies which led to the conclusion that it was entirely feasible to build and operate a "first operating unit," consisting of a single tube under the river with appropriate approaches and appurtenances on both sides for approximately half the estimated cost of the entire project. On September 1, 1933, the Port Authority entered into an agreement with PWA for a loan of $37,500,000, bearing interest at 4 per cent. Construction of the first operating unit is now well under way, and is expected to be completed early in 1938.

It was realized that proceeding in this manner by stages would increase the cost of construction by several million dollars. But this might be offset in a few years by a saving in interest in case the traffic should not develop and produce the necessary revenue, and in the face of falling traffic even to undertake the first unit involved a risk. On the other hand, the Port Authority considered it its duty to aid in the creation of employment as much as possible without endangering its credit standing.

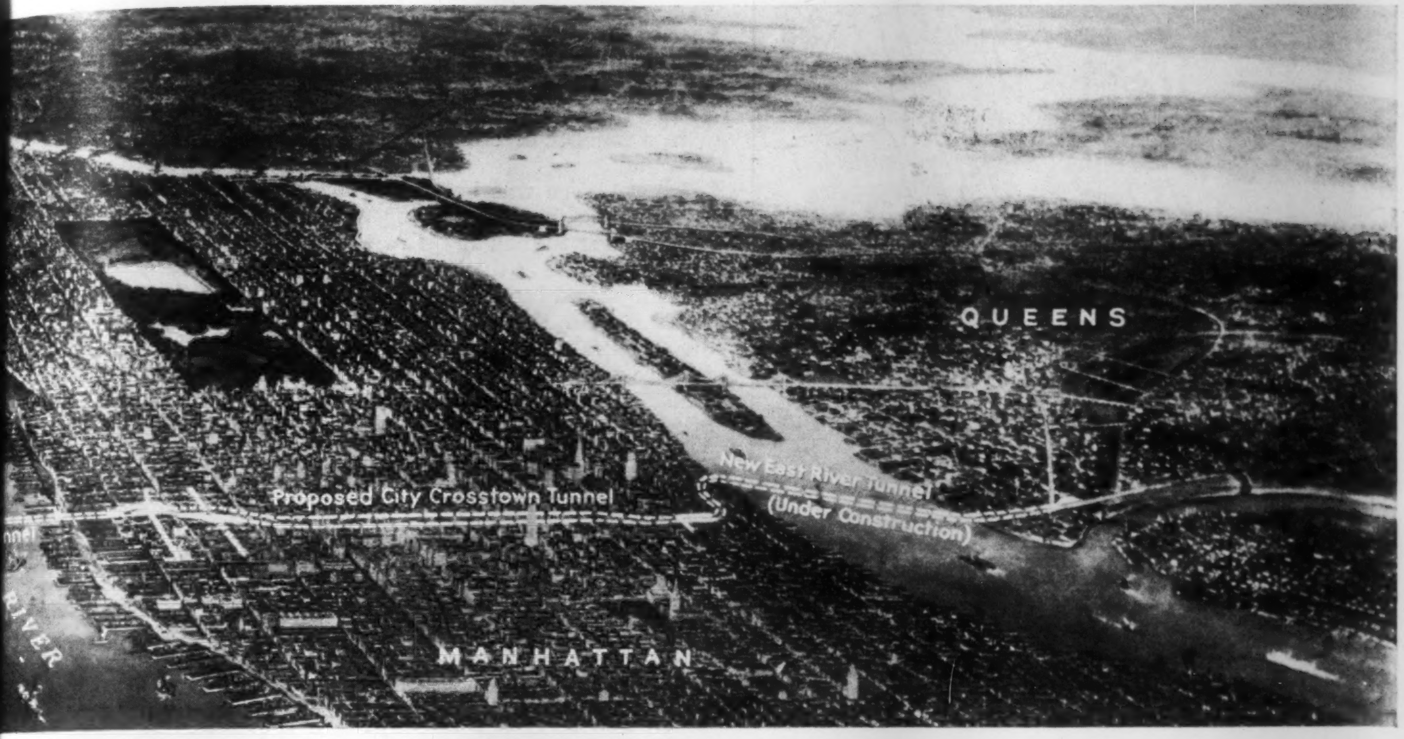
In 1935, owing to improvement in business conditions, the Port Authority found it practicable to float bonds, the proceeds of which enabled it to repay all PWA advances and to meet further construction costs for the first operating unit. At the same time PWA agreed to provide an outright grant of about $4,800,000 to help finance extension of the first operating unit westward across Union City to the junction with N. J. Routes 1 and 3 in the Hackensack meadows.

In view of the decided upturn in traffic in 1936, with continued improvement in the bond market, the Port Authority late in 1936 decided to go forward with the construction of the second river tube, and still more recently it concluded the financing of the entire project with a view to carrying it to completion as rapidly as possible. Work on the second tube is already under way, and it is expected that the entire project will be completed by the end of 1940. A bird's-eye perspective is shown in Fig. 2.

LOCATION OF TUNNEL AND NEW YORK CONNECTIONS

Recent observations indicate that the location of the tunnel, three miles north of the Holland Tunnel and seven miles south of the George Washington Bridge, is ideal, since it represents approximately the center of gravity of the entire cross-river traffic within the metropolitan area (Fig. 3). Thus the tunnel should shorten materially the time and distance for many vehicles which now travel for miles south or north in congested Manhattan in order to cross the Hudson through the Holland Tunnel or over the George Washington Bridge. On the New Jersey side the tunnel will give more direct access to midtown Manhattan from such important residential and industrial centers as Newark, the Oranges, Passaic, and Paterson.

An important factor in selecting the general location for the Lincoln Tunnel was the proximity of the proposed vehicular tunnel across Manhattan and the 38th Street tunnel now under construction under the East River by the New York City Tunnel Authority. With these it will form an arterial highway connecting New Jersey directly with both the west and east sides of Manhattan and with Long Island.



Showing How the Lincoln Tunnel Will Connect with the Crosstown and East River Tunnels

Probably the most difficult part of the project was the planning of the approaches and highway connections, and determining the exact location of the tunnel. There were available the studies (1) of the Holland Tunnel commissions, made under the direction of Ole Singstad, M. Am. Soc. C.E., their chief engineer, and (2) those of the Port Authority, made by J. C. Evans, terminal engineer, with the assistance and advice of James Forgie, M. Am. Soc. C.E., consulting engineer. The two sides of the river presented radically different problems and led to a variety of solutions for the approaches and for the tunnel location.

Conditions in New York were particularly involved (Fig. 4). The act authorizing the construction of the tunnel specified that the entrance and exit should be located in the area west of Ninth Ave, between 35th and 41st streets. As this entire area is intensely developed, it was essential to reduce to a minimum the destruction of ratable property and interference with the existing comprehensive railroad freight-terminal facilities. Economy demanded avoiding destruction or reconstruction of the expensive piers and docks which occupy the waterfront and undue interference with shipping during tunnel construction.

The most formidable obstacle was offered by the New York Central Railroad's West Side improvement project, then already planned and now being carried out. These improvements cover the area bounded by 34th and 37th streets and Eleventh and Twelfth avenues. From 34th Street north the tracks are carried in a subsurface structure between Tenth and Eleventh avenues, making it necessary to carry the tunnel approach either under or over the depressed section.

On Twelfth Avenue the city was building the West Side Express Highway, the foundations of which might interfere with the construction of the tunnel. The possibility of a direct traffic connection between the tunnel and the express highway had also to be considered. However, that plan was abandoned at an early stage as too expensive, and also because it might create too much concentration of traffic on the elevated express highway. Ninth Avenue, the easterly boundary of the approach area, carries an elevated railroad, whose columns materially reduce the avenue's traffic capacity. For this reason Ninth Avenue had to be disregarded as a major north and south artery for tunnel traffic.

Finally it was essential to so locate and design the Lincoln Tunnel approaches as to make possible suitable future connections with the city's proposed Crosstown Tunnel, and suitable entrances and exits to the latter for crosstown traffic having its origin or destination on the west side of Manhattan. It was desirable to so plan these connections that through traffic would not be obliged to come to the surface or to utilize city streets.

A large number of solutions to these problems were offered by members of the engineering and operating staffs of the Port Authority, by its consulting engineers, and by the chief engineers of the city departments which cooperated with the Port Authority—the Borough of Manhattan, the Board of Transportation, and the Board of Estimate and Apportionment. Some 120 more or less different schemes were developed. Many of the earlier schemes failed to conform with one or more of the various requirements and limitations, and a process of elimination materially reduced the number.

But before any definite selection could properly be made, or any one plan rendered satisfactory, it was found necessary to set up elaborate specifications prescribing minimum traffic flow, capacities of roadways, and similar limitations.

LOCATING THE NEW YORK APPROACHES

Largely to minimize interference with existing and proposed railroad terminal facilities, the location of the tunnel exit and entrance was narrowed down to the area occupied by the six blocks bounded by Ninth and Eleventh avenues and 37th and 40th streets. Choices for location of the river tunnel also reduced themselves to

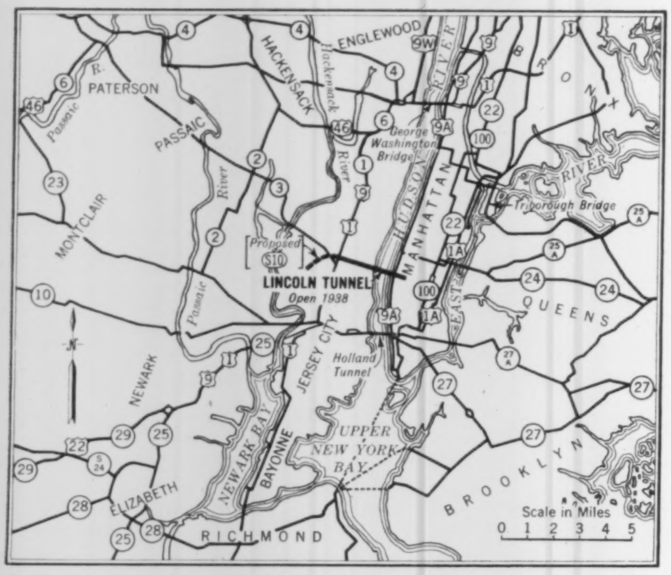


FIG. 3. MAP OF NEW YORK METROPOLITAN AREA

two—one approximately in line with 34th Street, and the other in the vicinity of 39th Street. The first location would provide a greater distance between the river tunnel at the bulkhead line and the terminal areas, thus permitting the approach tunnels to pass under the New York Central improvements and emerge, with grades not exceeding $3^1/_2$ per cent, into open plazas in any one of the blocks west of Tenth Avenue. The 39th Street location, on the other hand, while permitting straighter alignment of the approach tunnels with the river tunnel, would necessitate location of the plazas in the blocks between Ninth and Tenth avenues.

Fundamentally different ideas were developed with respect to the arrangement of the entrance and exit facilities. One group of planners aimed at decentralization by separating entrance and exit plazas so that they would be one or more blocks apart as in the Holland Tunnel, also by locating the plazas for the Lincoln Tunnel and the Crosstown Tunnel in different blocks. A second group, on the contrary, aimed at centralization of the terminal facilities in two or more adjacent blocks by segregating and merging all traffic before it left or after it entered the terminal area. The idea of decentralization by separation of exit and entrances undoubtedly has merit, but the studies brought out clearly that unless such separation is considerable, congestion in the vicinity of the terminal areas may be as severe as in the case of a centralized terminal.

All the early schemes contemplated the arrangement of surface plazas adjacent to one or more avenues, but it soon became apparent that direct and concentrated flow of traffic between tunnel plazas and the avenues should be minimized or eliminated altogether, if congestion in the avenues was to be avoided. Furthermore, property costs could be materially reduced by avoiding acquisition of the more expensive properties adjacent to the avenues. These considerations led to the development of a radically different idea, namely, the substitution for surface plazas of funnel-shaped depressed plazas connecting with new surface streets carrying tunnel traffic only. These new streets were planned to run north and south from the depressed plazas through the middle of several blocks, connecting with a number of crosstown streets between the existing avenues.

Final choice was between two schemes based on the latter idea, but embracing the alternative locations for the river tunnel, at 34th and 39th streets, respectively (Fig. 5). The 39th Street location was finally adopted and approved by a joint committee composed of representatives of the city and the Port Authority, largely on account of its materially lower cost and lesser interference with pier facilities and the New York Central Railroad improvements, and because it permitted the opening of new surface roadways to the south as well as to the north of the plazas.

The south or exit plaza of the Lincoln Tunnel occupies the westerly half of the block bounded by Ninth and Tenth avenues and 38th and 39th streets. As a part of the first operating unit it will serve initially for both entrance and exit traffic, but under the ultimate arrangement, which comtemplates construction of the plazas of the city's Crosstown Tunnel, the entrance plaza of the Crosstown Tunnel will be situated in the east half of the same block and the Lincoln Tunnel plaza will be used for an exit only. The new approach roadway (recently named Dyer Avenue in honor of the late Gen. George R. Dyer, former chairman of the Port Authority) is located midway between Ninth and Tenth avenues and extends from 34th to 42d Street. It will serve the traffic leaving the Lincoln Tunnel, and ultimately the traffic entering the Crosstown Tunnel. A similar plan is under way for westbound traffic in the block between Tenth and Eleventh avenues and 39th and 40th streets, where the Crosstown Tunnel exit plaza and the Lincoln Tunnel entrance plaza are jointly served by a new approach roadway constructed over the depressed tracks of the New York Central Railroad. This approach has been named Galvin Avenue in honor of the late John F. Galvin, also a former chairman of the Port Authority.

In planning the approaches to the Lincoln Tunnel,

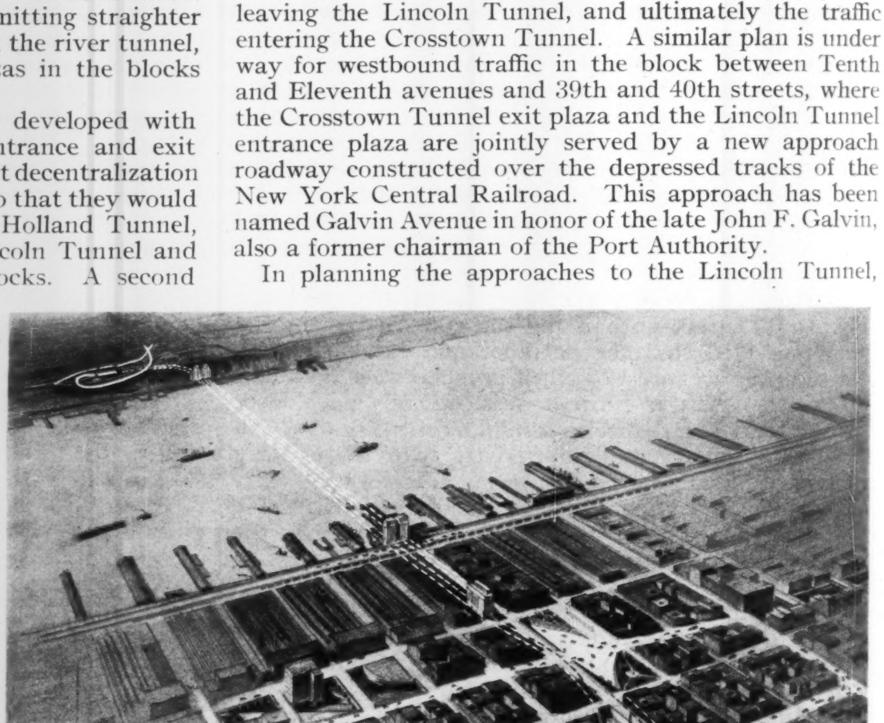


FIG. 4. PERSPECTIVE OF NEW YORK APPROACH TO THE LINCOLN TUNNEL
Detail of Jersey Approaches (Seen in Distance) Is Shown on Cover

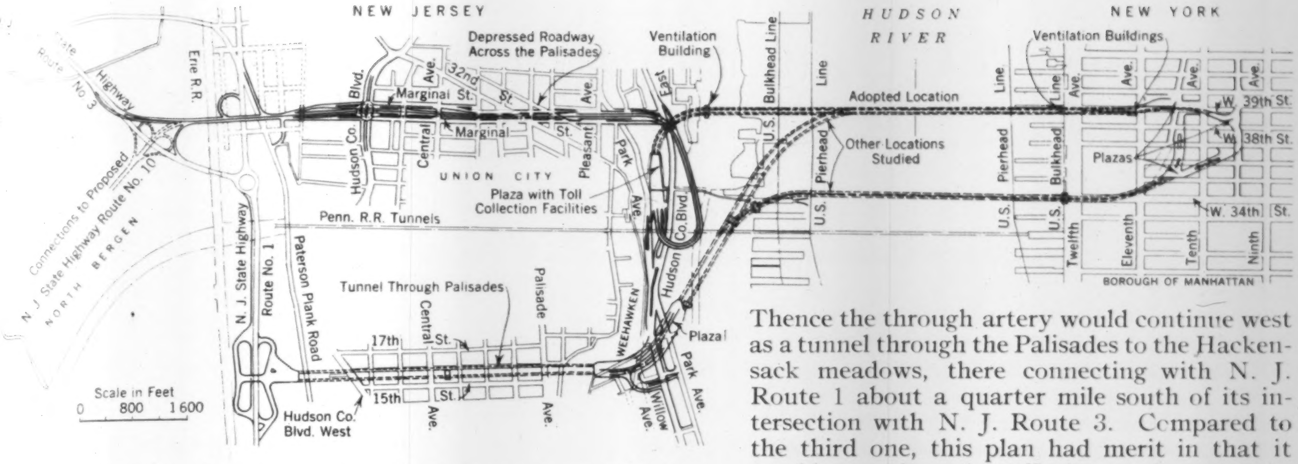

NEW JERSEY
HUDSON RIVER
NEW YORK
Depressed Roadway Across the Palisades
Ventilation Building
Ventilation Buildings
Adopted Location
Other Locations Studied
Plazas
Plaza with Toll Collection Facilities
Tunnel Through Palisades
Plaza
Penn. R.R. Tunnels
Erie R.R.
State Route No. 3 Highway
Connections to Proposed N. J. State Highway Route No. 10
NORTH BERGEN
UNION CITY
WEEHAWKEN
N. J. State Highway Route No. 1
Paterson Plank Road
Hudson Co. Blvd.
Hudson Co. Blvd. West
Marginal St.
32nd St.
Central Ave.
Pleasant Ave.
Palisade Ave.
Park Ave.
Willow Ave.
East
Hudson Co. Blvd.
17th St.
15th St.
U.S. Bulkhead Line
U.S. Pierhead Line
W. 39th St.
W. 38th St.
W. 34th St.
Twelfth Ave.
Eleventh Ave.
Tenth Ave.
Ninth Ave.
BOROUGH OF MANHATTAN
Scale in Feet
0 800 1600

Fig. 5. Map Showing Alternative Locations of the Lincoln Tunnel, with Existing and Proposed Highway Connections

ample reservoir space has been provided to avoid traffic overflow and congestion. If the Crosstown Tunnel is built, about 25 per cent of the total Lincoln Tunnel traffic is expected to pass directly to and from its tubes without using city streets.

NEW JERSEY APPROACHES OFFER DIFFICULT PROBLEM

Adoption of the 39th Street location in New York did not entirely fix the alignment of the river tunnel, for this depends in part on the solution to the approach problem on the New Jersey side. Opposite 39th Street the Palisades rise almost vertically to a height of about 150 ft, barely leaving space for the New York Central tracks along the shore. Further to the south, however, the easterly ridge of the Palisades drops off sharply and low ground exists for about 1,000 ft back from the shore. This space, as well as the waterfront, is occupied largely by railroad facilities and by the arteries of Hudson County Boulevard East and Park Avenue, but sufficient unoccupied area remains for exit and entrance plazas with toll-collecting facilities. West of this low ground, the Palisades rise to a mile-wide plateau occupied by Union City, and thereafter slope down gradually toward the Hackensack meadows.

The act authorizing the construction of the tunnel stipulates not only that the New Jersey approach shall extend west of the Palisades to permit connections with New Jersey state highway routes in the vicinity of the Erie Railroad tracks, but also that entrance and exit shall be provided in the Township of Weehawken, located on the easterly side of the Palisades. This requirement, while fully justified, very materially complicated the problem, because in addition to exit and entrance facilities in Weehawken for under-river tunnel traffic, consideration had to be given to other traffic which might use the new artery across the Palisades.

Three essentially different general schemes were investigated. One would have extended the under-river tunnel on virtually the same straight alignment through the Palisades without requiring through traffic to rise to the surface. But the connections in Weehawken, which would have involved merging and diversion of traffic underground, introduced a controversial as well as an expensive problem, and accordingly this otherwise excellent plan was abandoned.

Another plan contemplated curving the tunnel from the New Jersey pierhead line to the south to emerge at the surface of the low land east of the Palisades (Fig. 5), where exit and entrance facilities were to be provided. Thence the through artery would continue west as a tunnel through the Palisades to the Hackensack meadows, there connecting with N. J. Route 1 about a quarter mile south of its intersection with N. J. Route 3. Compared to the third one, this plan had merit in that it would save through traffic from going over the Palisades.

Neither of these two plans would have given Union City and other communities on top of the Palisades convenient access to the river tunnel or to its extension through the Palisades. There was also a demand for a better arterial highway between the top of the Palisades and the state highways in the Hackensack meadows. These considerations led to the investigation of a third scheme, an open-cut depressed roadway through Union City with marginal surface streets on each side, serving both as a through connection for tunnel traffic and as an improved artery for local as well as through traffic between the east and west sides of the Palisades. To gain height without excessive grades it was found necessary to develop a loop or horseshoe turn rising from the tunnel portal to the depressed roadway at the top of the Palisades, with exit and entrance plaza and toll-collection facilities on the low ground in Weehawken as part of the loop. The open-cut plan was finally approved by the Port Authority, as well as by committees composed of representatives of local New Jersey communities, and county and state officials.

In the comparison, consideration was given not only to first cost of construction (lowest for the open-cut scheme), but also to cost of maintenance and operation (also lowest for the open cut), time and cost to the traveling public by reason of distance, grades, and curves (somewhat lower for the tunnel scheme), and other economic factors. The open-cut plan was later subjected to further elaborate comparative studies, largely in order to meet the desires of the local community. As an alternative to the loop, a horseshoe arrangement for gaining height was investigated, but was finally abandoned as not meeting traffic needs as well as the loop.

The Weehawken plaza provides for the collection of all tolls and, at its south end, makes a direct connection with Park and Willow avenues, which will serve traffic to and from Hoboken on the south. Starting at this end of the plaza, the loop viaduct structure swings to the east to pass over the Hudson County Boulevard East, and on rising grade recrosses it and Park Avenue north of the plaza, making suitable ramp connections with the main north and south streets. West of Pleasant Avenue the express roadway will be a depressed structure flanked by marginal surface streets. At Hudson County Boulevard West, ramp connections are provided. A short distance west of this boulevard the express highway becomes a viaduct structure on a descending grade towards the west, where it makes connections with N. J. Routes 1 and 3 and the proposed Route 10 in the Hackensack meadows.

Geology of Dam Sites in Shale and Earth

Outlining the Limiting Factors Inherent in the Shales and in Gravel, Sand, Silt, and Clay Foundations

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WHAT foundation properties should be investigated in selecting a site for a masonry dam on shale? Which are the most vital features when the structure is an earth dam to be based on gravel, sand, silt, or clay? Questions such as these, of primary importance to builders of dams, are fully answered in the accompanying article by Professor Mead. The constitution and physical properties of shale are discussed in detail, and a distinction is made between compaction shales and cemented shales. Problems of bearing strength and elasticity, resistance to sliding, prevention of leakage under or around the dam, and preparation of foundations in shale are next considered. Foundations of earth dams are treated comparatively briefly, with special attention to those founded on alluvial deposits. This article is taken from Professor Mead's paper presented on September 10, 1936, at Washington, D.C., before the Second Congress on Large Dams. For other aspects of the general problem, reference may be made to a companion article, "Geology of Dam Sites in Hard Rock," published in the May 1937 issue.

TECHNICALLY, the term "shale" is perhaps limited to fine-grained argillaceous sediments with well-developed, thin-bedded stratification, and with the property of splitting or parting in thin layers. But in this article the term is used in a broader sense to include, without regard to bedding laminations, all fine-grained sedimentary rocks which were originally deposited in the form of clay or mud and have undergone various degrees of solidification and lithification by processes of compaction, crystallization, and cementation. (Slate, the cleavable metamorphic equivalent of shale, is not included.) Shales have a range in physical properties from those of clay to strong weather-resisting rock with properties approaching those of slate. With gradual increase in grain size, shale may grade through silty shale to sandstone; with admixtures of varying amounts of calcium and magnesium carbonates, shale may grade into limestone and dolomite.

Shales may be divided into two types: (1) "Compaction shales," which have been consolidated by compaction, with little or no intergranular cementation; and (2) "cemented shales," which have undergone maximum compaction and in addition a cementation or "setting" process. There is no sharp line of demarcation between these two types.

CHARACTERISTICS OF COMPACTION SHALES

Compaction shales slake and disaggregate when acted upon by water after partial or complete drying, the rapidity and completeness of disaggregation being largely dependent upon the completeness of the drying. In its natural condition of saturation, core drilled from compaction shale below the water table, when placed in water, very slowly absorbs additional water and develops expansion cracks. These expansion cracks, however, may be due, at least in part, to elastic expansion of the rock.

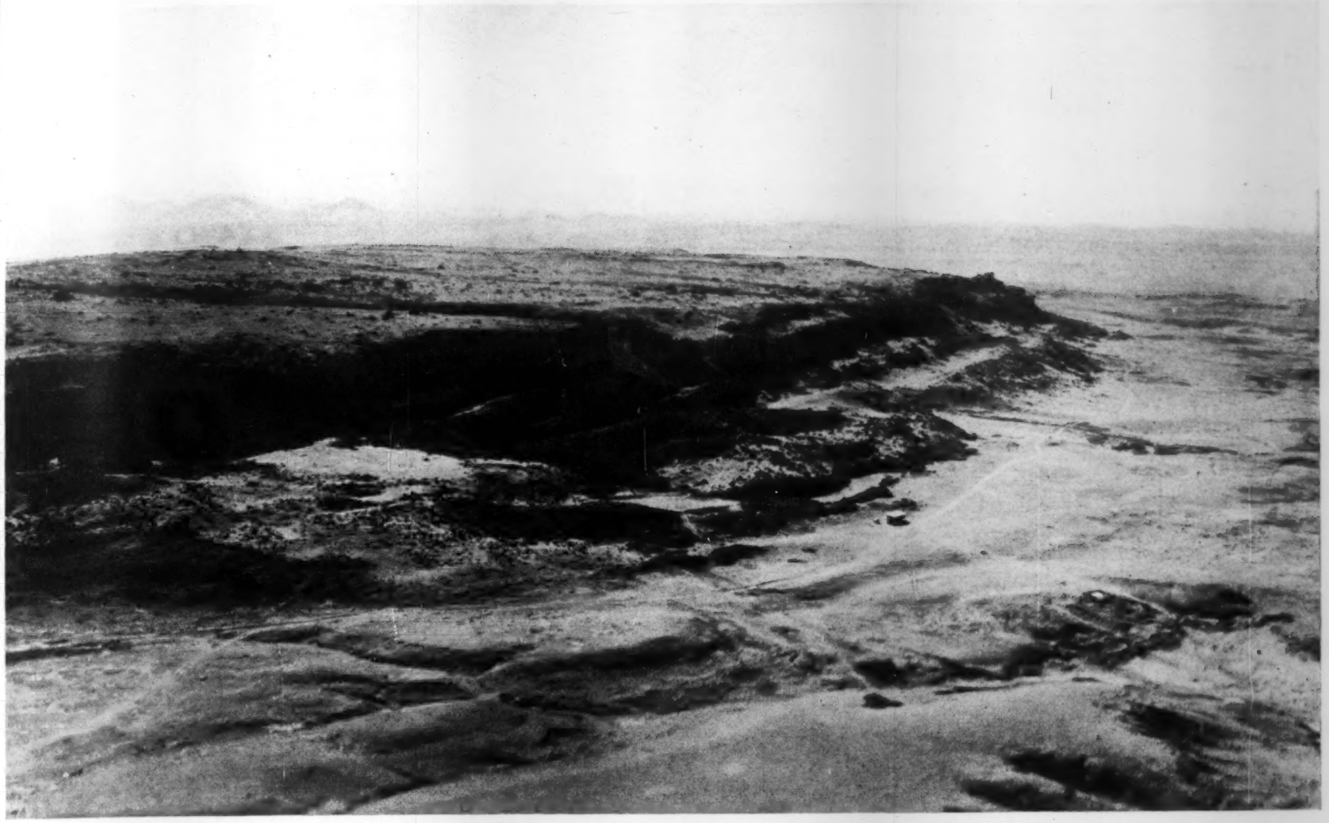
Well-cemented shales do not disaggregate when placed in water after previous drying. Intermediate types may crack and fall apart, particularly along the planes of bedding, but do not undergo extensive disaggregation. Slaking tests—the treatment of dried samples by immersion in water—throw much light on the nature of a shale and indicate the degree of care which must be exercised in preparing foundations for concrete.

In the case of compaction shale, it is reasonable to infer that in its natural saturated condition in the ground each constituent particle is surrounded by a tenaciously held film of water, and that, because of this condition, the rock is plastic and will deform by flow under sufficient stress differential. I have demonstrated this property for both the Ft. Union and the Bearpaw shales by closely fitting sections of drill core in its natural moist condition into a section of steel tubing and forcing the shale to flow out of a half-inch orifice by applying pressure to the end of the core by means of a closely fitting steel piston. Cemented shales will not flow in this manner.

The tendency of compaction shale to disaggregate in water after partial drying is shared by other argillaceous rocks, particularly hydrated or kaolinized volcanic ash or fine-grained volcanic tuff. In this latter category is the Cucuracha formation, through which the Gaillard cut of the Panama Canal was excavated, and in which extensive slides occurred owing to the plastic deformation of the material. Also in this general class of slakable rocks are certain conglomerates having a clay or shale matrix, as well as certain types of glacial till, particularly those derived from the glacial reworking of shale formations.

All these rocks merit careful attention in the examination of foundations, abutments, and reservoir-rim formations in arid and semi-arid localities where the water table is deep and where partial desiccation to considerable

BORING LARGE HOLES IN BEARPAW SHALE FOR SPILLWAY FOUNDATION AT THE FORT PECK DAM



Compaction Shales May Be Deformed by the Weight of Superincumbent Beds When Lateral Support Is Removed

Airplane View of Snake Butte near Harlem, Mont. The Shale Foundation Has Failed Plastically Under the Weight of the Igneous Rock Butte. When Breaks Occur, the Masses of Rock Subside, Tilting Back Towards the Cliff and Uplifting the Shale in Front

depths is possible. Rock in this class may appear adequately strong and tight in the dry condition in natural exposures or in excavations, but it will slake disastrously under the action of water. The failure of the St. Francis Dam in southern California in 1928 has been ascribed by some investigators to the unsuspected presence of slakable argillaceous rock in one of the abutments. It is excellent practice to make slaking tests of all doubtful rocks.

The bearing strength of compaction shales in their natural saturated condition increases with the degree of compaction, and the natural water content decreases as the degree of compaction increases. If a shale is restrained, its capacity to carry load without yielding other than elastically is increased in proportion to the restraint, as flowage can only occur when material can move away from the loaded area. This fact has long been recognized by engineers, and the method of "floating" structures on shale by first removing a mass equivalent to the load of the structure has been widely used.

CEMENTED SHALES COMPARATIVELY RELIABLE

Cemented shales are much more reliable from the standpoint of bearing strength, and ordinarily will not tend to yield by flowage under dam construction. Their strength is comparable to that of concrete, but they have greater elastic deformation under load than concrete has.

It is of prime importance to investigate the elasticity coefficients of any shale foundation for masonry dams. The relatively high elasticity should be taken into account in design so that deflection of the foundation under load variations between full and empty reservoir can be reduced to a satisfactory minimum or be properly allowed for. An undesirable degree of elastic deformation may open grout cutoffs, damage bond between concrete and foundation rock, and possibly produce undesirable effects by exerting a kneading action on the shale.

Compaction shales may be deformed by the weight of superincumbent beds when lateral support is removed, as by erosion, which may leave high steep cliffs, thus concentrating the load on the shale. This condition may be suspected when open joints are found in the overlying rock. In some instances, however, the overlying rock may have been removed by erosion, and the fact that the shale has been deformed may be less obvious. Masses of shale which have once failed under the load of overlying rock are weakened and are less acceptable as foundation and abutment rock than similar undisturbed shale. A multitude of shear zones, accompanied by deep local weathering, is to be expected, resulting in zones of wet, plastic clay. Careful geological studies should be made in advance of design when there is any reason to suspect this condition.

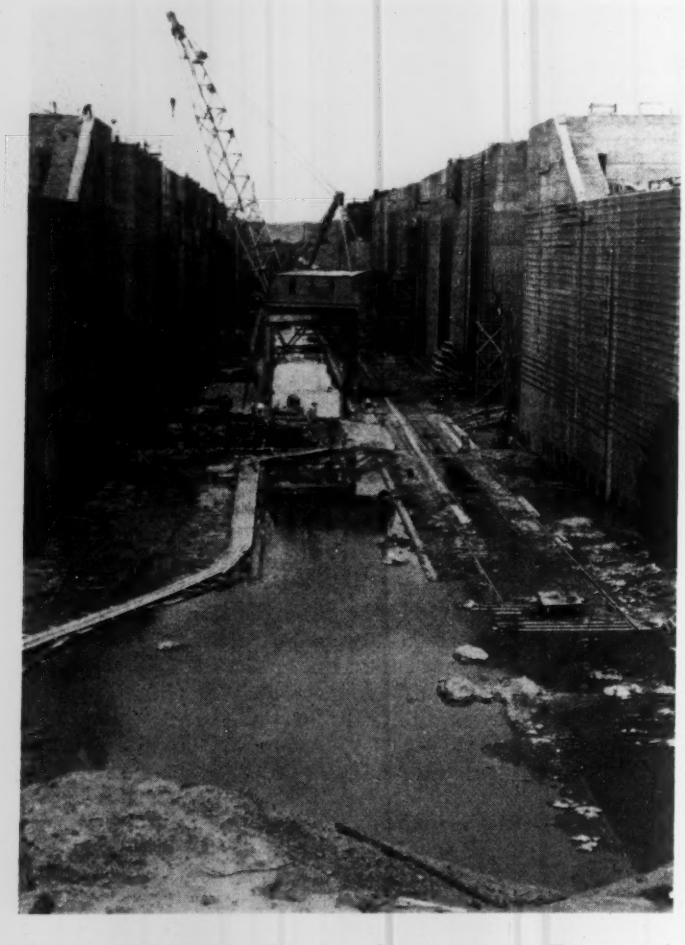
The irregular boundary surface between concrete and shale beneath a dam practically eliminates the need for investigating the coefficient of friction of concrete on shale. Investigation of resistance to sliding involves rather the shearing strength of the foundation shale along surfaces on which sliding might theoretically occur. It is advisable to attempt to determine the shearing strength of shale by testing core specimens taken from the foundation rock.

A special device was constructed for investigating the shearing strength of shale at the Tygart Dam in West Virginia. It consisted of a stationary block and a sliding member, each containing an opening in which part of the shale core was imbedded. By means of car springs, an appropriate load was applied in a direction perpendicular to the plane of movement between the two members. Tabulations of shearing tests of this type are of little value for general purposes, however, on account of the wide variation in the nature and properties of shales. Tests should be made in each case on the shale involved, and no reliance should be placed on results obtained elsewhere.

Resistance to sliding is of course increased by throwing the potential shear planes as deeply as possible into the shale, and securing an increased buttressing effect from the rock downstream. In constructing the gate structure of the spillway at the Fort Peck Dam (founded on a relatively soft shale), increased resistance to sliding is provided by a large number of reinforced-concrete dowel pins approximately 30 ft deep, placed in 5-ft auger borings in the shale foundation and tied into the concrete floor of the structure.

PREPARING SHALE FOUNDATIONS FOR CONCRETE

Care should be taken in the preparation of shale foundations. After excavating any alluvial material from the stream bed, all deteriorated shale should be removed so as to expose fresh, unaltered natural surfaces. The exposure of compaction shale to other than a saturated atmosphere results in loss of water by evaporation, with accompanying development of shrinkage cracks. When concrete is applied to a partially dried shale surface, or even to one where drying has just begun, the surface layer slakes and forms a permanent mud or soft clay layer between the masonry and the rock. To avoid this condition, every measure possible should be taken, permitting only the shortest possible time interval between final preparation of the rock surface and placing of concrete, and protecting the prepared surface during this interval by prompt application of a coating of asphaltic or other suitable waterproofing material. Laboratory experiments and actual practice at Fort Peck, Mont., and at Tygart, W. Va., have demonstrated that the bond between concrete and compaction shales is distinctly better when the shale surfaces have been promptly treated with such coating.



CONSTRUCTING LOCK AT PICKWICK LANDING ON THE TENNESSEE, SHOWING FOUNDATION PREPARED FOR CONCRETE

Compaction shales, in common with all rocks, are in a condition of more or less elastic strain due to natural conditions, and tend to expand towards free surfaces in excavations. Because of their extremely low tensile strengths, compaction shales have little resistance to such elastic expansion. This results in the opening of cracks, joints, or bedding partings near exposed surfaces, and therefore constitutes an added reason for allowing only a minimum of time between final preparation of excavated surfaces and placing of concrete.

Shale foundations in general are very satisfactory from the standpoint of imperviousness. The plasticity of compaction shales under load tends either to prevent the formation of open joints, cracks, and fissures, or to heal by flowage those which may exist. Solution channels do not occur except where soluble limestone beds are interstratified with the shale. However, in the more compact types of compaction shale, a minor number of open joints may exist and should of course be grouted. Cemented shales may have open joints, fractures, fissures, or shear zones, which should be grouted to prevent leakage.

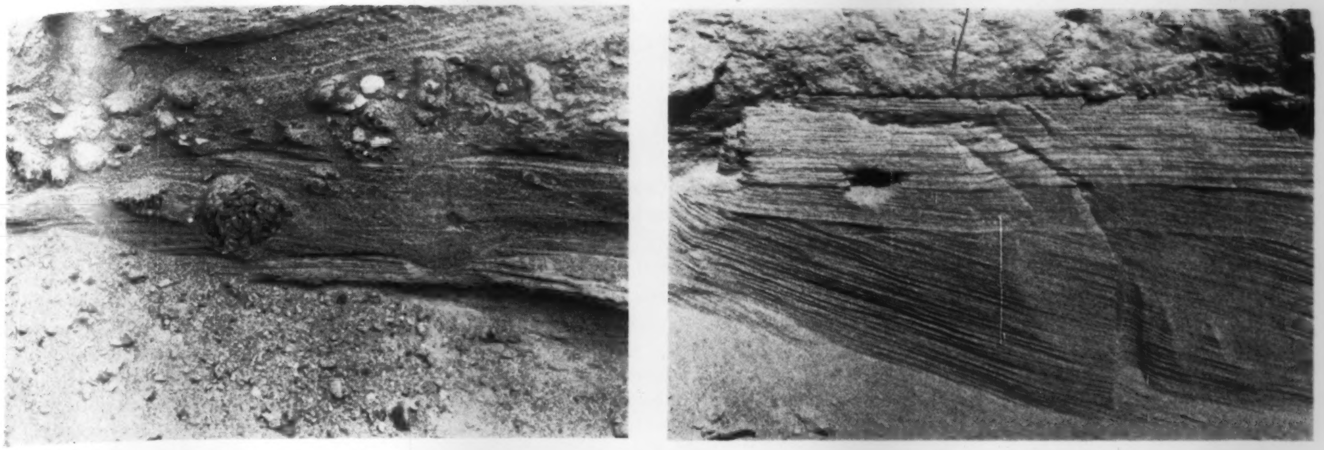
Because of the laminated structure of most shales, their low coherence along bedding planes, low tensile strength, and plastic and elastic properties, grout pressure should be kept at a safe minimum. Pressures should be limited to the load of the rock and dam above the level of grouting, as excessive grout pressure may lift or deform the mass.

In shale foundations and abutments containing interstratified layers of sandstone, particular attention should be given to the condition of the shale immediately below such layers. As these sandstone beds are in general permeable, they are often the locus of movement of ground water, and frequently the shale layer immediately beneath is softened and deteriorated.

Under the attack of surface weathering, compaction shales revert to clay by slaking under alternate drying and wetting, elastic expansion, and absorption of moisture. The depth of weathering is limited by the imperviousness and insulating properties of the resulting clay mantle. In shales intermediate between the compaction and cemented types, weathering penetrates more rapidly into the least cemented layers. Interstratified beds of highly compacted shales which are only in an initial state of cementation may revert to a condition of low-grade compaction for considerable distances into the abutments, while the cemented shale above and below remains essentially unchanged. Well-cemented shale has a considerable degree of resistance to weathering and may stand exposed in natural cliffs in the manner of sandstone and limestone, but when completely weathered, it reverts to a residual clay.

TYPES OF FOUNDATIONS FOR EARTH DAMS

In earth dams founded on rock, the problem of bearing strength in effect disappears, but the problems of leakage through rock under and around the structure are no different from those just discussed for a concrete dam. Resistance to sliding on or within the foundation is



Section of Hydraulic Fill, Showing Clay Balls in Sand

Cross-Bedding in River-Deposited Sand

VIEWS SHOWING CHARACTERISTICS OF SAND AT THE FORT PECK DAM

minimized, as the structure is itself weaker in shear than the foundation.

In considering construction of an earth dam on alluvial deposits of river valleys, it should be kept in mind that these are stream-borne products derived from erosion of the surface of the drainage basin and varying in character with the nature of the terrain from which they are derived, the shape of the valley, and the gradient of the stream. In terms of particle size, materials range from huge boulders in the mountain streams; through cobble, gravel, and sand in the less rapid watercourses; to silt and the finest colloidal clay, interstratified with sand, on the flood plains of sluggishly moving rivers. Similar clays having high colloidal content are found in lake deposits, in glacial clays, and in certain types of glacial till.

The treatment of earth-dam foundations which consist of boulder deposits, gravel, sand, or mixtures of these materials, involves only the question of the control of leakage through the foundation. Materials of this type have a bearing strength and a resistance to deformation and sliding which are superior to the earth dam itself. However, this type of foundation material is pervious and calls for thorough field and laboratory investigations of its permeability, including, where possible, permeability tests on "undisturbed" samples, inferences as to probable permeability based on mechanical analyses, and, in special instances, field measurements of the rate of flow of water through the material.

Construction of earth dams on flood-plain deposits containing fine sand, silt, and clay in varying proportions, presents a variety of problems and calls for a careful survey and thorough study of existing conditions. Certain fundamental properties of the several types of alluvial materials will now be briefly summarized.

PROPERTIES OF SAND, SILT, AND CLAY

River-deposited sand is characteristically laid down with a high percentage of voids. This open-packed sand is susceptible to compaction under the load of a dam, but the amount of compaction which it will undergo under a given load is not proportional to its initial percentage of voids. Laboratory experiments on the sand of the flood plain at the Fort Peck Dam site indicate that a compaction of approximately 8 per cent of the thickness of the sand may be expected under the load of the dam.

Silt is likewise deposited in a state of open packing. It is susceptible of compaction and increases in bearing strength and stability therewith.

Compaction of sand and silt is dependent on the escape of the contained water. With slow application of load and adequate opportunity for escape of water, consolidation occurs and produces increased bearing strength and resistance to deformation, but if the load is applied too rapidly to permit the escape of water, or if such escape is inhibited by less pervious materials, the open-packed sand and silt tend to flow out from under a superimposed load. It is therefore important that every reasonable provision be made to insure escape of water from sand and silt in earth-dam or embankment foundations.

Where impervious surface layers of clay or clayey soil are present, special provision should be made to insure opportunity for adequate upward drainage of the water pressed out of the foundation by the weight of the structure. In some cases toe-drainage is adequate; in other cases gravel or rock-filled drainage trenches cut through the surface layer are desirable; and in extreme cases the stripping of the impervious layer from the entire area of the dam may be indicated.

Clay is inherently plastic and has the properties of a viscous fluid. It tends to flow from beneath an applied load to points where the load is less. Its initial movement may be extremely slow and may continue unnoticed over a considerable period of time, to be culminated by a period of rapid movement. Clay appears to have a certain inherent capacity to resist deformation, but when loaded beyond this limit to the point of initial movement, its resistance to further deformation is very much less than the initial resistance of the undisturbed mass.

Clay undergoes compaction under load, but the rate is much too slow for the engineer to make use of this phenomenon in design or construction. Furthermore, the product, although stronger in shear, is still plastic. Clay must be considered to be potentially a viscous fluid having little bearing strength unless adequately restrained on all sides, and incapable of safely and permanently supporting more than very moderate loads. Countless examples of the natural failure of clay foundations under over-steepened river bluffs are to be observed.

Much attention has been and is being given to investigations of the bearing strength of clay in the field of soil mechanics, and excellent progress has been made in developing methods of analysis of clay foundation conditions by investigation of the distribution of shearing stresses, and by measurements of shearing strength, elastic properties, and degree of compaction. Analyses such as these lead to the quantitative determination of safe load factors.

Operating Characteristics of Cars on Grades

Balanced Grades Up to Six Per Cent Cause Negligible Increases in Operating Costs

By John A. Oakey

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GRADE determinations are vital in modern highway design, governing in large part, as they do, expenditures for cuts and fills. Since the justification for such expenditures rests chiefly upon resulting economies in automobile operation, measurements of the effect of grades upon operation costs are very important. In the accompanying article Mr. Oakey outlines two series of tests on late-model passenger automobiles. The first series determined the "floating" grade down which a given car can travel with the throttle closed and without the use of brakes. The second group fixed approximately the relationship between amount of grade and gasoline consumption. While the tests described are incomplete, they tend to show that balanced grades up to 6 per cent cause negligible increases in gasoline consumption and tire wear and no increase whatever in the items of brake wear and oil consumption.

VARIOUS attempts have been made from time to time to prove or disprove the theory that grades increase the cost of operating motor vehicles. Many authorities hold that grades increase such costs because gasoline consumption is greater on plus grades, while any saving in gasoline on minus grades is offset by increased wear on the brakes. But Prof. H. B. Shaw of North Carolina State College, in his article, "Highway Grades and Motor Vehicle Costs," in the 1932 *Proceedings of the Highway Research Board*, showed that, according to tests he had made on one car, grades up to a certain magnitude caused no increase in operating costs. This is corroborated by the tests described herein, analyzed by a method for which I am indebted to Prof. Shaw. Despite the fact that the tests are incomplete, they illustrate certain extremely important operating characteristics of the modern car on grades.

The tests referred to were made on nine different makes of modern (1936) passenger automobiles under the supervision of Neil MacCoull at the Beacon (N.Y.) laboratory of the Texas Company. The chassis dynamometer used at the laboratory is shown in the accompanying Fig. 1. The car to be tested is run onto the weighing scales and is then moved forward until its rear wheels rest directly over the dynamometer drums where it is anchored securely with four wire cables.

The dynamometer drums, which are operated by the rear wheels, are made of compressed fiber strengthened and weighted with cast-iron rings, and are mounted on a spiral-beveled axle. The power developed by the car is transmitted to the drums and thence to the axle, which in turn transmits power through a regular truck propeller shaft and gear box to an electric generator and then through a second propeller shaft, axle assembly, and belt connection to a large centrifugal fan or blower. The drum-axle housing is supported on ball bearings and its torque is taken up by a fabricated triangular beam connected to an automatic weighing device through suitable linkages. Wind velocities comparable to road service can be attained by operation of the centrifugal fan which blows air over the front of the car under test.

TRACTIVE EFFORT AND RESISTANCES

The tractive effort of a car engine must be sufficient to overcome the three types of resistance to which the car is subjected, namely, rolling resistance, air resistance, and grade resistance. This relation may be expressed by

$$E = R_r + R_a \pm R_g \ldots\ldots [1]$$

The tractive effort may be plus or minus, depending on whether the grade resistance is of sufficient negative magnitude to counteract the sum of the other two resistances.

Rolling resistance is the resistance to movement of the car along a level roadway with the clutch disengaged. It is influenced by so many factors that average values must be assumed for it. Some of these factors are the weight of car, type of lubricant, temperature, type and inflation of tires, type of road surface, and velocity.

Air resistance varies according to the formula,

$$R_a = KAV^2 \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

In this formula, K is an experimentally determined constant depending on the shape of the car; A is the car's projected frontal area in square feet; and V is its velocity in miles per hour. Studies by Professor W. E. Lay, of the University of Michigan, on various shapes of car models indicate that for the modern partially stream-lined car, K varies from 0.0005 to 0.0008. A conservative value of 0.001 will be used for K in this article. The projected area of the car will be assumed as 25 sq ft.

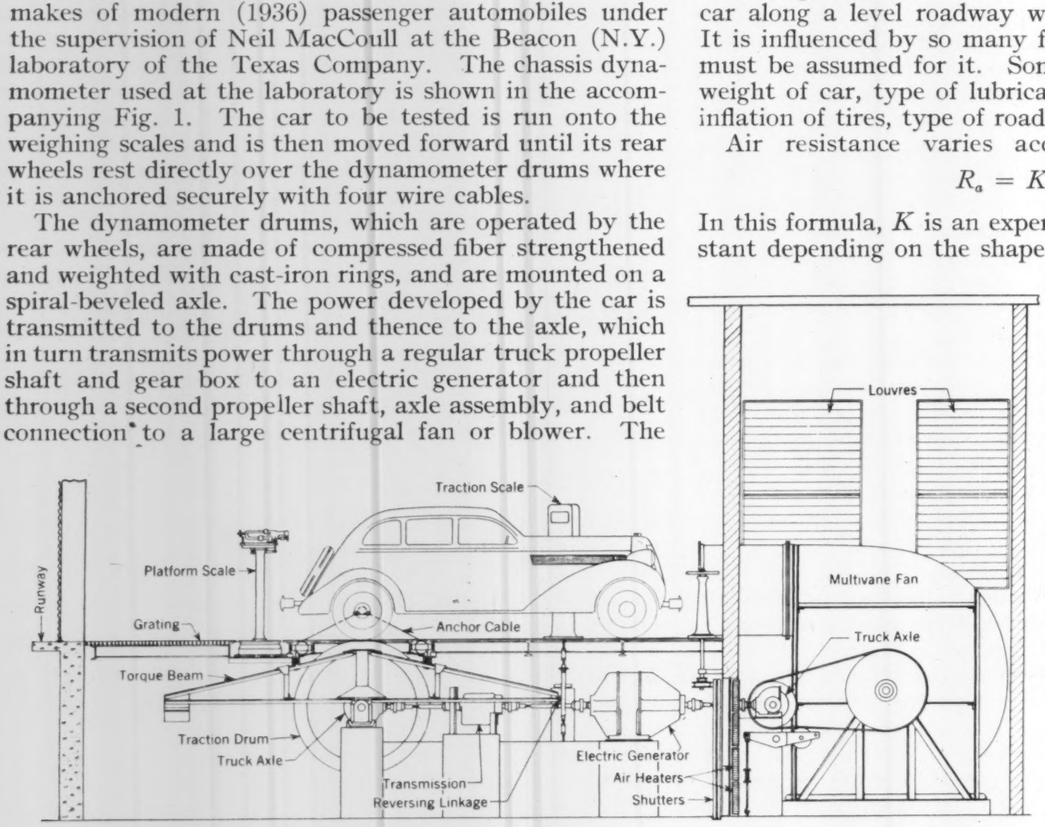

Fig. 1. Schematic Elevation of Chassis Dynamometer Installation Used in the Tests

Grade resistance to a vehicle is given by the well-known formula,

$$R_g = \pm 20\,TG \ldots [3]$$

in which T is the weight of the vehicle in tons, and G

is the grade in per cent. This resistance may be plus or minus, depending on whether the vehicle is traveling on a plus or minus grade.

From these considerations, the total tractive effort of the car engine (Eq. 1) becomes,

$$E = R_r + 0.025V^2 \pm 20TG,$$

and the horsepower developed becomes

$$P = \frac{EV}{375} \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

The first series of tests was run to determine the "floating" grade down which cars can travel in high gear at a uniform speed of 40 mph with the throttle closed and without the use of brakes. The data gathered from dynamometer tests on the cars are given in Col. 3 of Table I.

TABLE I. FLOATING GRADES FOR CARS AT SPEEDS OF 40 MPH

		THROTTLE CLOSED, ENGINE NOT FIRING	THROTTLE CLOSED, ENGINE FIRING			
CAR NO. (Col. 1)	CAR WEIGHT IN LB (Col. 2)	Traction in Lb. (Col. 3)	Traction in Lb (Col. 4)	Rolling Resistance R_r in Lb (Col. 5)	Total Tractive Effort E in Lb (Col. 6)	FLOATING GRADE % (Col. 7)
1	3,900	195	183	23	−160	6.6
2	4,040	222	209	24	−185	7.1
3	3,150	218	205	19	−186	8.7
4	3,310	184	173	20	−153	7.3
5	4,210	210	197	25	−172	6.5
6	3,090	166	156	18	−138	7.3
7	3,610	208	196	21	−175	7.4
8	3,360	187	176	20	−156	7.3
9	3,200	180	169	19	−150	7.4

A more complete test on Car 8 gave the data shown in Table II. It will be noted that at high speeds the traction is essentially the same regardless of whether the engine is firing or not. At 40 mph the traction when the engine of Car 8 is firing is 94 per cent of the traction when it is not firing. If this factor, 94 per cent, is applied to the tractions of the other cars when the throttle is closed and the engine is not firing, the tractions given in Col. 4 of Table I are obtained.

A test at 40 mph on Car 8 with the transmission in neutral showed that the rolling resistance of the rear wheels on the dynamometer drum was 20 lb. The rolling resistances of the other cars were not determined, but no great error will be introduced if it is assumed that rolling resistance varies directly with the weight. From this assumption, the rolling resistances shown in Col. 5 of Table I were obtained. These values subtracted from Col. 4 give values for the various tractive efforts in Col. 6. When the cars are going downhill at 40 mph, with the car in high gear, the throttle closed, and the engine firing, these tractive efforts are drags and are therefore marked minus. I believe that the conditions on which Col. 6 is based very closely approximate those actually occurring when a car is "floating" down a grade.

TABLE II. OBSERVED RELATION BETWEEN TRACTION WITH AND TRACTION WITHOUT ENGINE FIRING, CAR 8

	TRACTION IN LB	
CAR SPEED In mph	Engine Not Firing	Engine Firing
20	150	120
30	170	150
40	187	176 (interpolated)
50	204	200

From the data in Cols. 2 and 5, Table I, the "floating" grades down which the cars can travel at 40 mph without the use of brakes were determined. A rolling resistance of 30 lb per ton will be assumed. This value corresponds to the rolling resistance on good concrete at 40 mph. The maximum allowable grades for the various cars, computed by substituting the proper values in the basic equation,

$$E = R_r + 0.025V^2 \pm 20TG,$$

appear in Col. 7 of Table I.

EFFECT OF GRADES ON GASOLINE CONSUMPTION

A second series of tests was run to determine the effect of grades upon the gasoline consumption of modern cars. Complete tests were run on Cars 5 and 8 only. The results of these tests are shown in Col. 2 of Tables III and IV. The grades indicated in Tables III and IV are merely those equivalent to the loads placed on the dynamometer. In Col. 3 they have been reconverted to grade resistances in pounds by the use of Eq. 3. To these grade resistances have been added rolling resistances of 25 lb and 20 lb for Cars 5 and 8, respectively, giving the total tractive efforts shown in Col. 4. These tractive efforts have been converted into developed horsepower, as shown in Col. 5 by the use of Eq. 4. In Fig. 2 the gasoline consumption in gallons per mile is plotted against horsepower for the two cars.

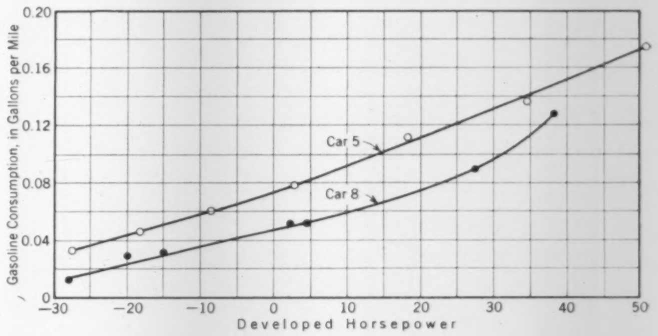

FIG. 2. RELATION BETWEEN GASOLINE CONSUMPTION AND DEVELOPED POWER

From the data presented in Fig. 2, it is possible to determine what the gasoline consumption on various actual plus and minus grades would be, assuming the rolling and air resistances the same as in the analysis of the first series of tests. The total tractive effort is given by Eq. 1., and the developed horsepower by Eq. 4. The gasoline consumption is secured from Fig. 2. The results of these computations appear in Tables V and VI.

Since automobile trips are always round trips, and since most motorists follow the same route going both ways, the effect of any grade on gasoline consumption may be taken as the amount the average consumption uphill and down exceeds the consumption on the level. For instance, let us assume that Car 5 must pass over a stretch of 6 per cent grade on a certain trip. Going up grade, the gasoline consumption is 0.148 gal per mile, while going down it is 0.050 gal per mile. The average of these two values is 0.099 gal per mile, an excess of

TABLE III. OBSERVED RELATION BETWEEN GRADES AND GASOLINE CONSUMPTION FOR CAR 5, AT 40 MPH

No Allowance Made for Air Resistance

GRADE %	GAS CONS. Gal per Mile	GRADE RESISTANCE R_g in Lb	ROLLING RESISTANCE R_r in Lb	TRACTIVE EFFORT $R_g + R_r$ in Lb	DEVELOPED HORSEPOWER
10.7	0.176	451	25	476	50.8
7.1	0.137	299	25	324	34.6
3.5	0.113	147	25	172	18.3
0.0	0.079	0	25	25	2.7
−2.5	0.061	−105	25	− 80	− 8.5
−4.7	0.047	−198	25	−173	−18.4
−6.7	0.034	−282	25	−257	−27.4

0.004 gal per mile over the gasoline consumption on the level. The results of similar computations are given in Table VII and in Fig. 3.

From these two series of tests, several valuable conclusions can be drawn. In the first place, it may safely be stated that the modern car can travel down grades as steep as 7 per cent at 40 mph without the use of brakes. If the roadway is rougher than good concrete, or if the speed is higher, grades greater than 7 per cent may be descended without the use of brakes. Therefore, if highway engineers adhere to a maximum grade of 6 per cent, braking will not be necessary at normal speeds.

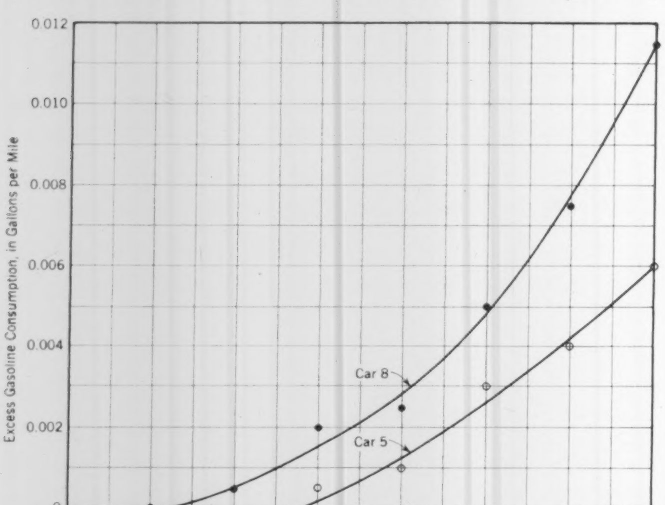

FIG. 3. RELATION BETWEEN EXCESS GASOLINE CONSUMPTION AND GRADE

It may not be possible to draw accurate conclusions regarding gasoline consumption from tests on only two cars. However, these tests suggest certain valuable conclusions, since Car 5 is a typical modern heavy car and Car 8 is a typical modern light car. In Fig. 3 it will be noted that gently rolling grades up to 3 per cent cause a reduction in gasoline consumption for Car 5. The same is true for grades up to 1 per cent for Car 8. Above these grades, gasoline consumption is increased. On a 6 per cent grade, the excess gasoline consumption is 0.0042 gal per mile for Car 5 and 0.0078 gal per mile for Car 8. On a 6 per cent grade a mile long, the additional gasoline consumed in the two miles traveled up and down the grade would be 0.0084 gal for Car 5 and 0.0156 gal for Car 8. With gasoline priced at 20 cents per gal, this represents costs of 0.168 and 0.312 cent for cars 5 and 8, respectively. Compared to the total cost of motor-vehicle operation, these costs are insignificant. Their insignificance is further emphasized by the fact that the motorist rarely meets a 6 per cent grade a mile long.

TABLE IV. OBSERVED RELATION BETWEEN GRADES AND GASOLINE CONSUMPTION FOR CAR 8 AT 40 MPH

(No Allowance Made for Air Resistance)

GRADE %	GAS CONS. Gal per Mile	GRADE RESISTANCE R_g in Lb	ROLLING RESISTANCE R_r in Lb	TRACTIVE EFFORT $R_g + R_r$ in Lb	DEVELOPED HORSEPOWER
10.1	0.128	339	20	359	38.3
7.0	0.091	235	20	255	27.2
0.6	0.052	20	20	40	4.3
0.0	0.051	0	20	20	2.1
−4.8	0.031	−161	20	−141	−15.0
−6.2	0.029	−208	20	−188	−20.0
−8.4	0.012	−282	20	−262	−28.0

TABLE V. COMPUTED RELATION BETWEEN GRADES AND GASOLINE CONSUMPTION FOR CAR 5 AT 40 MHP

GRADE %	GRADE RESISTANCE R_g in Lb	TOTAL TRACTIVE EFFORT E in Lb	HORSE-POWER	GAS CONS. Gal per Mile
7	295	398	42.5	0.158
6	253	356	38.0	0.148
5	211	314	33.5	0.139
4	168	271	28.9	0.129
3	126	229	24.4	0.121
2	84	187	19.9	0.112
1	42	145	15.5	0.103
0	0	103	11.0	0.095
−1	− 42	61	6.5	0.086
−2	− 84	19	2.0	0.077
−3	−126	− 23	− 2.5	0.070
−4	−168	− 65	− 6.9	0.063
−5	−211	−108	−11.5	0.057
−6	−253	−150	−16.0	0.050
−7	−295	−192	−20.5	0.044

To those who believe that the additional resistance caused by grades increases tire wear, it should be pointed out that the modern car can be equipped with new tires at a cost not exceeding $40. Since such tires, when properly maintained, will last for 20,000 miles, the tire cost is 0.2 cent per mile. Compared with the wear caused by the innumerable stops, starts, checks, and accelerations to which tires are subjected, the wear caused by grades must be negligible. Tests prove that oil consumption is affected only by engine speed, not by power output.

TABLE VI. COMPUTED RELATION BETWEEN GRADES AND GASOLINE CONSUMPTION FOR CAR 8 AT 40 MPH

GRADE %	GRADE RESISTANCE R_g in Lb	TOTAL TRACTIVE EFFORT E in Lb	HORSE-POWER	GAS CONS. Gal per Mile
7	235	325	34.6	0.113
6	202	292	31.1	0.101
5	168	258	27.5	0.092
4	134	224	23.9	0.083
3	101	191	20.4	0.077
2	67	157	16.7	0.070
1	34	124	13.2	0.065
0	0	90	9.6	0.060
−1	− 34	56	6.0	0.055
−2	− 67	23	2.5	0.051
−3	−101	− 11	− 1.2	0.047
−4	−134	− 44	− 4.7	0.042
−5	−168	− 78	− 8.3	0.038
−6	−202	−112	−11.9	0.034
−7	−235	−145	−15.5	0.030

In conclusion, it may be stated that grades up to 6 per cent cause no increase in brake wear or in oil consumption. Also, despite the fact that gasoline consumption is increased slightly, and tire wear perhaps to some extent, these increases are so small as to be negligible. However, it cannot be denied that, when trucks impede the movement of traffic or when roads are slippery, grades are to be avoided, since under these conditions they increase driving costs and hazards.

TABLE VII. EXCESS GASOLINE CONSUMPTION UP AND DOWN GRADES AT 40 MPH

GRADE %	FOR CAR 5		FOR CAR 8	
	Av. Gas. Cons. Gal per Mile	Excess Gas. Cons. Gal per Mile	Av. Gas. Cons. Gal per Mile	Excess Gas. Cons. Gal per Mile
0	0.095	0	0.060	0
±1	0.0945	−0.0005	0.060	0
±2	0.0945	−0.0005	0.0605	0.0005
±3	0.0955	0.0005	0.062	0.002
±4	0.096	0.001	0.0625	0.0025
±5	0.098	0.003	0.065	0.005
±6	0.099	0.004	0.0675	0.0075
±7	0.101	0.006	0.0715	0.0115

Acknowledgment is again made to Mr. MacCoull of the Texas Company for running the tests upon which this paper is based, and to Professor Shaw of North Carolina State College for suggesting the method of analysis used.

Geodetic Control for a County Line

Plane-Coordinate System Facilitates Work of Establishing a Straight Boundary

By Philip Kissam

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ADVANTAGES of the plane-coordinate system are again demonstrated by Professor Kissam in connection with the recent establishment of a straight boundary line for three New Jersey counties where the original markers were not properly lined up. By utilizing this system it was possible to base the entire survey control for the work on the fundamental triangulation net of the U. S. Coast and Geodetic Survey without resort to any geodetic computations. The coordinate system also made it relatively easy to locate the most probable position of the boundary as a straight line such that the sum of the squares of its rectangular offsets to existing monuments should be a minimum. In other words, the method of least squares was utilized. The resulting general formula, as applied by Professor Kissam, unquestionably will be very helpful for use elsewhere.

PRESUMABLY a straight line, the tri-county line separating the New Jersey counties of Camden and Gloucester on the northwest from Atlantic County on the southeast (Fig. 2), is about twenty miles long. The exact location of the line had been in doubt for many years, and in fact the few existing monuments that marked it were not all known to the county officials. In many localities it was impossible to determine in which county property holdings were situated, and there was much divergence of opinion as to how far each county should maintain the roads which crossed the line.

Beale M. Schmucker, Assoc. M. Am. Soc. C.E., county engineer of Camden County, proposed that a survey be made from which it would be possible to determine the location of existing marks, and establish a straight line to form the basis of an agreement between the three counties. He organized an emergency project for this purpose and requested the advice of the New Jersey Geodetic Control Survey as to the proper procedure to put the plan into operation. The Survey recommended that a complete traverse loop be established, extending along each side of the county line at a distance of approximately a mile and a half and following convenient highways and railroads to facilitate accurate surveying. A traverse connection was to be made between the two sides of the loop along each important road or highway crossing the tri-county line, and the entire network thus developed was to be tied in wherever possible to the triangulation stations of the U. S. Coast and Geodetic Survey.

The survey methods used were to be in accordance with the specifications of the U. S. Coast and Geodetic Survey for second-order work. In order to effectuate this plan, the New Jersey Geodetic Control Survey offered the services of a supervisor in that district and supplied a pair of its own steel tapes, which were compared each month under the direction of the Survey with a master tape standardized by the U. S. Bureau of Standards.

Highways and Railroads Were Followed to Facilitate Accurate Surveying

In accordance with this plan, reconnaissance was made for the traverses, and pairs of monuments were built at short intervals along the lines. The monuments of each pair were placed approximately a quarter of a mile apart for the purpose of giving direction as well as position control. One pair of monuments was located on each cross connection so that the tri-county line fell between them, as nearly as could be determined. While the field work was in progress, the U. S. Coast and Geodetic Survey established an arc of triangulation extending from Newport to Freehold in such a direction that it completely covered the tri-county line. Wherever possible, the monuments established for the traverse were used for triangulation stations, and where this was not possible the Bureau established triangulation stations near the traverse line. Such stations were connected with the traverse net by the field party engaged in measuring the traverses.

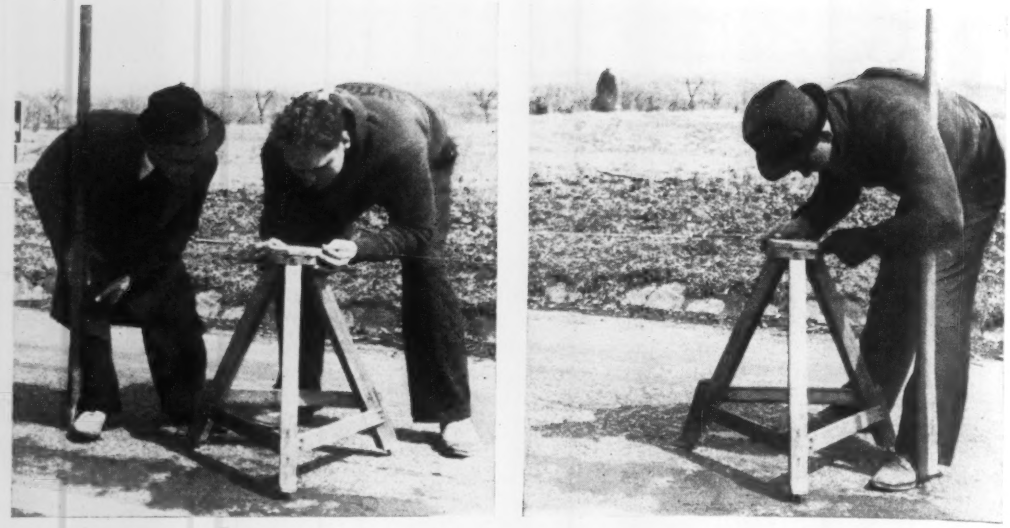
Table I. Summary of Lengths and Closures of Tri-County Traverses

Traverse No.	Length in Miles	Ratio of Closure
ATL-14	4.280	1:20,751
ATL-15	5.249	1:18,019
ATL-16	5.200	1:10,965
ATL-17	4.464	1:28,535
ATL-18	3.266	1:48,581
ATL-21	4.102	1:39,452
BUR- 2	3.754	1:18,460
BUR- 3	4.757	1:19,826
CAM-10	6.968	1:19,592
CAM-11	3.805	1:45,704
CAM-12	2.917	1:27,748
CAM-13	6.726	1:27,548
CAM-14	4.299	1:17,273
CUM- 1	3.000	1:14,132
GLO- 3	4.530	1:27,560
GLO- 4	4.290	1:85,809
GLO- 5	2.549	1:41,039
Average length..	4.362 Average ratio..	1:30,058

During the work the field party learned from contact with local persons of six existing county-line monuments, each of which was recovered and made part of a traverse loop connected with the traverse net.

TRAVERSE COMPUTATIONS

It was decided that the computations should be made entirely by the New Jersey Geodetic Control Survey.



Front-Contact Man Checks Position of Pin While Tension Man Watches the Spring Balance

One Man Can Make Rear Contact and Read Off the Temperature to the Chief of Party

FRONT AND REAR CONTACTS OF TAPING PARTY AT WORK

The geographic positions of the triangulation stations were reduced to the New Jersey system of plane coordinates, and the geodetic azimuths established at these stations were converted into grid azimuths on the same system. Each grid azimuth as thus determined was carried through the angles of the traverse to the grid azimuth at the next nearest triangulation station. If comparison with the final azimuths showed a total error of less than 3 sec per angle, the discrepancy was distributed equally among the angles of the traverse.

With the new azimuths thus obtained, the latitude and departure of each course were computed, and the error of closure determined. If the closing error was less than one part in 10,000, the error in latitude and the error in departure were distributed throughout the line in proportion to the lengths of the various courses, and the final coordinates of each monument were thus computed. All traverses run satisfied these requirements for closure. Similar methods were applied to the traverses connecting the old tri-county line monuments, and thus the positions of these markers were expressed in terms of the New Jersey system of plane coordinates. A list of the traverse closures appears in Table I.

LINE OF UNIFORM AZIMUTH ADOPTED

From the coordinates of the monuments on the old tri-county line, as thus determined, it was ascertained that a line connecting them would be far from straight. It was thought that all interests would be best served if an agreement were obtained among the three counties and ratified by the New Jersey Legislature establishing a new straight boundary to replace the old one. The plan of adopting a line of uniform azimuth on the coordinate grid rather than a geodetic line seemed to present evident advantages, and a test was made to discover the extent of the variance between the two. Although the county boundary was twenty miles long, a straight line on Clarke's spheroid of 1866 and a straight line on the plane-coordinate system originating and terminating at the same points diverged at the middle only 0.12 ft, or one part in 440,000.

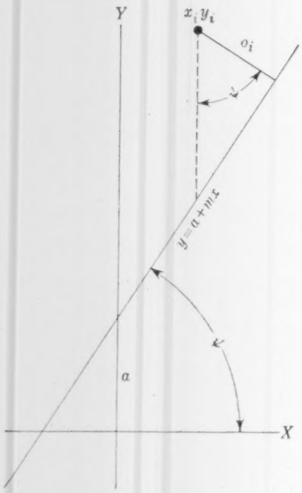


FIG. 1. ILLUSTRATING DEVELOPMENT OF EQUATION FOR PROPOSED TRI-COUNTY LINE

Since copies of the original field notes indicated that the surveyor while setting the original monuments had endeavored to establish a straight line, it was apparent that the new line should be a straight line averaging the old monuments. The coordinate system made available a very simple solution by the method of least squares.

Let the equation of the tri-county line (Fig. 1) be represented by the general equation:

$$y = a + mx$$

$$\text{where } m = \tan \psi$$

$$\text{Then the offset } o_i = \frac{y_i - a - mx_i}{\sqrt{1 + \tan^2 \psi}}$$

$$\text{Let } U = o_i^2 = \sum_1^n \left(\frac{y_i - a - mx_i}{\sqrt{1 + \tan^2 \psi}} \right)^2 = \sum_1^n \left(\frac{y_i - a - mx_i}{\sqrt{1 + m^2}} \right)^2 \quad \ldots\ldots [1]$$

Differentiating with respect to a and setting the result equal to zero,

$$a = \frac{\sum_1^n y_i}{n} - m \frac{\sum_1^n x_i}{n} \quad \ldots\ldots\ldots\ldots [2]$$

This shows, as was to have been expected, that the tri-county line must pass through the center of gravity of the old monument positions.

In order to determine the slope of the line, a may be eliminated by shifting the coordinate axes to the center of gravity. Equation 1 then becomes

$$U = \sum_1^n \left(\frac{y_i - mx_i}{\sqrt{1 + m^2}} \right)^2$$

where x_i and y_i are now coordinates with respect to the center of gravity. Differentiating with respect to m and setting the result equal to zero,

$$m^2 \sum_1^n y_i x_i + m \left(\sum_1^n x_i^2 - \sum_1^n y_i^2 \right) - \sum_1^n y_i x_i = 0$$

$$\text{Let } p = \sum_1^n x_i^2; \; q = \sum_1^n y_i^2; \; r = \sum_1^n x_i y_i$$

$$\text{Then } m^2 = \frac{p - q}{r} m - 1 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

By subtracting the average of the coordinates of the old monuments (that is, the coordinates of their center of gravity) from the original coordinates of the monuments, the coordinates of the monuments with respect to the center of gravity are determined. These values may be used to compute the quantities p, q, and r, which when substituted in Eq. 3 will give the quantity m. Equation 2 can now be solved for a. This procedure gave the equation of the proposed tri-county line as

$$y = 1.110430993\,x - 1{,}872{,}545.126$$

which is equivalent to

$$x = 0.9005512331\,y + 1{,}686{,}322.822$$

Solving this equation simultaneously with the equations of the lines determined by the pairs of monuments set on the crossroads, the coordinates of the intersections of these monumented lines with the tri-county line may be obtained. Finally, the difference in the bearings of the two lines in each case gives the angle between them at their intersection. With this information the new line can be marked on the ground.

PROPOSED LINE MAY BE DESCRIBED SIMPLY

Although the longer description given at the end of this article was recommended by the New Jersey Geodetic Control Survey, the only absolutely essential description would be as follows: "The line, expressed in terms of the New Jersey system of plane coordinates as set forth in Chapter 116 of the New Jersey Pamphlet Laws of 1935, is as follows:

$$y = 1.110430993\,x - 1{,}872{,}545.126$$

$$\text{or } x = 0.9005512331\,y + 1{,}686{,}322.822$$

This line extends from the northerly line of Cumberland County to the southerly line of Burlington County."

With the tri-county line thus described and tied permanently to the geodetic control survey of the United States, its position could never again be in doubt, no matter how many monuments might be lost or disturbed. It is inconceivable that so many triangulation stations of the U. S. Coast and Geodetic Survey and control monuments of the New Jersey Geodetic Control Survey might be lost that it would be impossible to re-establish the line, as every station of these surveys acts as a witness. It is also possible for any surveyor to determine where the tri-county line will cross any parcel of land, if he has connected his survey of that parcel to the control monuments of either of the two organizations mentioned.

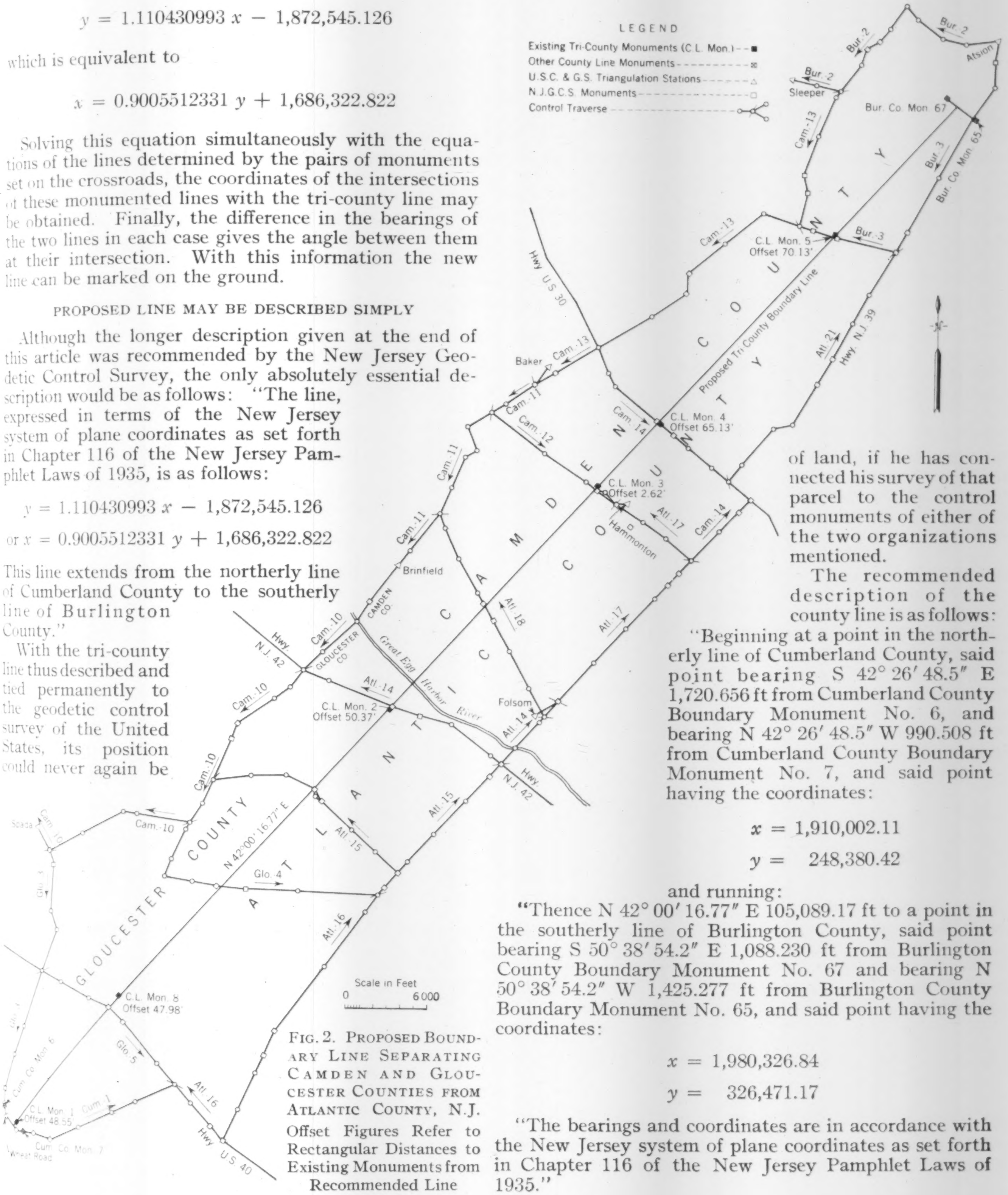

LEGEND
Existing Tri-County Monuments (C.L. Mon.) ■
Other County Line Monuments ⊠
U.S.C. & G.S. Triangulation Stations △
N.J.G.C.S. Monuments □
Control Traverse
Bur. 2
Atsion
Sleeper
Bur. Co. Mon. 67
Bur. Co. Mon. 65
Bur. 3
Cam. 13
C.L. Mon. 5 Offset 70.13'
Hwy. US 30
Proposed Tri County Boundary Line
CAMDEN COUNTY
Atl. 21
Hwy. N.J. 39
Baker
Cam. 11
Cam. 12
Cam. 14
C.L. Mon. 4 Offset 65.13'
C.L. Mon. 3 Offset 2.62'
Hammonton
Atl. 17
Brinfield
Atl. 18
ATLANTIC COUNTY
Cam. 10
Hwy. N.J. 42
CAMDEN CO.
GLOUCESTER CO.
Great Egg Harbor River
Atl. 14
C.L. Mon. 2 Offset 50.37'
Folsom
Atl. 15
GLOUCESTER COUNTY
N 42°00'16.77" E
Glo. 4
Atl. 16
Scale in Feet
0 6000
C.L. Mon. 8 Offset 47.98'
Glo. 5
Cum. Co. Mon. 6
C.L. Mon. 1 Offset 48.55'
Cum. 1
Cum. Co. Mon. 7
Wheat Road
Hwy. US 40

Fig. 2. Proposed Boundary Line Separating Camden and Gloucester Counties from Atlantic County, N.J. Offset Figures Refer to Rectangular Distances to Existing Monuments from Recommended Line

The recommended description of the county line is as follows:

"Beginning at a point in the northerly line of Cumberland County, said point bearing S 42° 26′ 48.5″ E 1,720.656 ft from Cumberland County Boundary Monument No. 6, and bearing N 42° 26′ 48.5″ W 990.508 ft from Cumberland County Boundary Monument No. 7, and said point having the coordinates:

$$x = 1{,}910{,}002.11$$

$$y = 248{,}380.42$$

and running:

"Thence N 42° 00′ 16.77″ E 105,089.17 ft to a point in the southerly line of Burlington County, said point bearing S 50° 38′ 54.2″ E 1,088.230 ft from Burlington County Boundary Monument No. 67 and bearing N 50° 38′ 54.2″ W 1,425.277 ft from Burlington County Boundary Monument No. 65, and said point having the coordinates:

$$x = 1{,}980{,}326.84$$

$$y = 326{,}471.17$$

"The bearings and coordinates are in accordance with the New Jersey system of plane coordinates as set forth in Chapter 116 of the New Jersey Pamphlet Laws of 1935."

The Modern Trend in Bridge Design

Produced by Improved Materials, Ingenuity in Selecting Types, and Esthetic Treatment

By C. W. Ogden

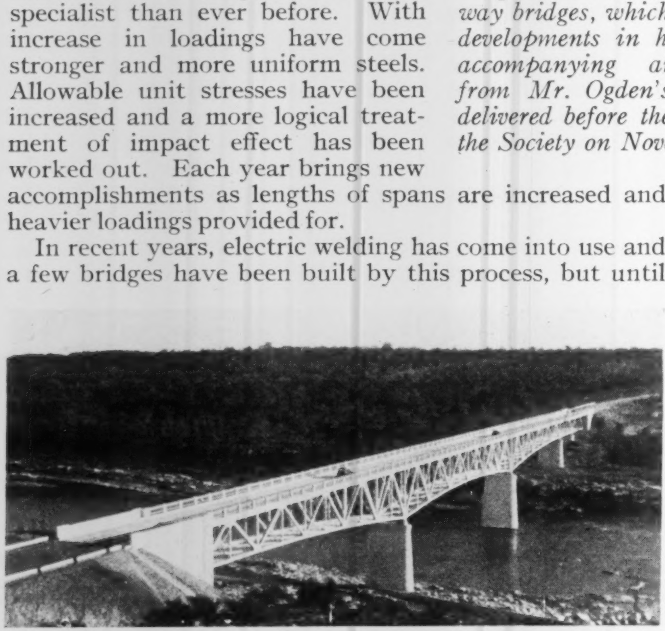
Member American Society of Civil Engineers
Assistant Chief Engineer, Virginia Bridge Company, Roanoke, Va.

To many persons the term "highway bridge" still calls up a picture of the ungainly spider-like through truss of two decades or more ago, with its rattling pin connections and vibrating plank flooring. Contrasted with this is the modern deck structure whose substantial but simple railings permit an unobstructed view from the concrete bridge floor. Many factors have entered into this transformation—among them new high-quality steel, extra-deep beams, simplification of details, ingenuity in type of design, and esthetic treatment of the bridge as a unit. Revision of the American Railway Engineering Association specifications has assisted in this process by raising allowable unit stresses, approving the use of alloy steels, and otherwise encouraging light weight and economy in the design of railway bridges, which parallel, in general, developments in highway spans. The accompanying article is abstracted from Mr. Ogden's interesting address delivered before the Virginia Section of the Society on November 14, 1936.

THERE has been nothing particularly new in recent years as to types of bridges. We still have our simple spans, both through and half-through; our deck structures, cantilevers, suspension bridges, bascules, lift bridges, arches, and swing spans. But although these types continue in general use, a great change has come about in loading, use of new materials, ingenuity and attention to details, selection of types for economy and utility, and esthetic treatment of bridges as units.

From the standpoint of the structural engineer, bridge designing has become more complicated. The increase in the kinds of materials and their adaptability to modern uses has made the designer more of a specialist than ever before. With increase in loadings have come stronger and more uniform steels. Allowable unit stresses have been increased and a more logical treatment of impact effect has been worked out. Each year brings new accomplishments as lengths of spans are increased and heavier loadings provided for.

In recent years, electric welding has come into use and a few bridges have been built by this process, but until more is learned of it and the costs and time required are reduced, it will be slow in replacing riveted construction. However, welding is being used economically in the structural shop and in the field to replace complicated and expensive riveted details. It is possible to substitute welded structural steel for many types of castings with a saving in weight, cost, and time. Repairs to and strengthening of old bridges are being effected by welding, often without interrupting traffic. Welding is being used increasingly in watertight floor construction, to replace caulking or to replace both riveting and caulking.



Continuous Deck-Truss Spans Over the Colorado River
Erected in 1936 near Marble Falls, Tex. Total Length, 894 Ft

The trend of design in railroad bridges has been shown by the effort to obtain more rigid structures, by the use of alloy steels for light weight and economy in the longer and heavier spans, and by the use of copper-bearing steel for protection against corrosion. Smoke and drippings from refrigerator cars have caused deterioration of paint and corrosion of steel in the older bridges to such an extent that replacements or expensive repairs have been necessary. More recent designs have made use of copper-bearing steel for deck bridges and for the floor systems of through bridges.

In recent years the continuous railroad bridge has been used more than ever before. The fear of reversional stresses has been removed and the objection to this type on account of possible pier settlement has been overcome. Engineers realize that good foundations are essential, insuring that settlement will be small and probable changes in reactions almost negligible.

To provide for more rigid structures, heavier loadings, and increased speeds, the A.R.E.A. specifications for steel railway bridges were revised in 1935. Briefly, the revised specifications recommend the use of rolled beams for spans up to 50 ft and discourage the design of pin-connected bridges for spans of less than 300 ft. Clearances have been changed somewhat from the 1925 requirement in order to provide for longer cars and heavier rails. Ties can now be spaced 6 in. apart instead of 4 in., and the weights of rails and fastenings have been increased to 200 lb per ft of track.

Cooper's E-72 loading is recommended, and the allowable tensile stress for carbon steel has been increased to

A Through Pin-Connected Truss Bridge Built in 1919
Note Light Construction, Wood Floor, and Wood Handrail

Bridge at Tyrone, Ky., Constructed in 1930 and 1931
The Center Span of This Deck Structure Is 360 Ft in Length

18,000 lb per sq in. This means that along with a 20 per cent increase in loading, a $12^{1}/_{2}$ per cent increase is provided in allowable unit stress. The effect of impact is treated more logically in the 1935 specifications. For a loaded length up to 25 ft, impact is approximately the same; but spans of 50-ft loaded length are to be designed for impact stresses amounting to 84.3 per cent of the live-load stress against 92.3 per cent as required by the 1925 specifications; 100-ft spans for 52.5 per cent instead of 75 per cent; 150-ft spans for 32 per cent instead of 58 per cent; 200-ft spans for 26.8 per cent instead of 43 per cent; and 250-ft spans for 24 per cent instead of 33 per cent. From this it can be seen that if the same loading is used in each case, designs made in accordance with the 1935 specifications will be lighter than those made under the 1925 specifications. Also, spans designed for an E-72 loading under the 1935 specifications will be practically the same weight as those designed for an E-60 loading under the 1925 specifications.

Methods proposed for determining lateral stresses will correct a real weakness in past designs. In some cases, these methods lead to results which appear unreasonable, but these must be taken as a means to an end.

The 1935 specifications also cover the use of silicon and nickel alloy steels which have been used in important railway and highway bridges and have proved satisfactory. The foreword to the specifications for alloy steels stated that as span lengths increase and the influence of dead load becomes preponderant, a span will be reached that costs the same whether built of carbon or of part alloy steel. In this case, the heavier carbon-steel span is still the better on account of its increased rigidity and greater thickness of material, offering more resistance to corrosion.

However, with increasing length of span the economy obtained by using alloy steels becomes pronounced, the features of rigidity and resistance to corrosion being adequately secured by an alloy-steel design. Unless there is extreme need for reducing the dead load, the floor systems for such spans should be of carbon steel. Studies are now being made to develop specifications for rivet steels of strengths suitable for economical use with alloy structural steels. Until this is accomplished, the carbon-steel rivet will continue to be used.

ADVANCES IN DESIGN OF SMALL HIGHWAY BRIDGES

The most remarkable advance in recent years has taken place in the design of highway bridges, that is, in the small bridges that account for the majority of the tonnage used in highway-bridge work. With increase in loads, more substantial bridges are being designed and built. No longer do we hear the rattle of the old pin-connected spans. These have been replaced by field-bolted or field-riveted structures with an occasional field-welded job. The minimum thickness of metal has been increased to $^{5}/_{16}$ and $^{3}/_{8}$ in. Wood floors have been replaced almost entirely by concrete or by steel-grid flooring filled with concrete. The latter weighs only one-fourth to one-third as much as the usual concrete floor, and moreover it is easily erected and requires no forms for the concrete filler. Stronger and more substantial-looking railings of simpler design also accompany the trend towards better and safer bridges.

Until a few years ago, the deepest I-beam rolled in our steel mills was 24 in. Then came the 27- and 28-in. beams, and more recently the 30-, 33-, and 36-in. beams. These deeper and stronger rolled beams have provided economical cross-sections. In a short time longer simple-span beam bridges came into use where formerly fabricated plate girders or truss spans had been employed. Later, designs were made for continuous-beam spans over three or more supports and for cantilever-beam spans.

All these types, having only railings above the bridge floor, give unobstructed views of the countryside, and to a great extent keep the driver from feeling hemmed in while passing over the structure. Speed as well as safety on the highways is increased by the use of these deck-type bridges, because the optical illusion of a narrowing roadway is almost entirely eliminated.

The continuous or cantiliver-beam bridge is usually made up of from three to five lines of beams, either without cover plates or with cover plates added at points of maximum moment, and with the concrete slab resting directly on the top flanges. Diaphragms connect the beams laterally. Details vary with different state highway departments. In the earlier examples of the cantilever type, the suspended span was supported from the cantilever arms by pin-connected links. Now the pins and links have been discarded in most designs, and the connection is made with a plate or slab fixed bearing at one end and having a sliding bearing at the other. Both bearings allow for deflection. Of course, slightly different details are used by various designers, but

Bridge Over the Virginian Railway at Roanoke, Va.
It Consists of Three Continuous Through Plate-Girder Spans of 121 Ft 6 In. Each, and One 61-Ft Beam Span

the tendency of all is towards a more rigid type of joint.

Continuous and cantiliver-beam spans have been used with maximum central spans of 100 to 110 ft between supports and total over-all lengths of 220 to 250 ft for three supports. In the belief that higher concentrations are not to be expected but that higher total loads are a distinct possibility, some highway engineers are designing for a 100 per cent increase in live load, using one-third higher combined allowable unit stresses than are specified under the usual H-15 or H-20 loading. Floor slabs are designed without this increase.

Shoes or bearings for these bridges vary considerably with the designer. Some use the fixed cast-steel pedestal and the cast-steel rocker-type expansion shoe. Others use the same detail except that the shoes are made up of welded plates and slabs. In still other designs, the expansion shoe is a single round steel roller as much as 12-in. in diameter, depending on the load to be carried. Practically all designs for shoes have advanced decidedly in simplicity, facilitating maintenance and assuring long life for this very essential detail.

The replacement of truss spans by simple-span and multiple-span beam bridges has reduced maintenance costs to a minimum. Where the usual watertight floor is used, the structural steel is almost entirely protected from the weather. Certain four-legged animals are no longer a menace, and there are fewer cracks or places for rust to start. The field-splicing of continuous or cantilever beams varies with different designers, and the location of splices may often be determined by shipping, hauling, or erection conditions. Sometimes they are located so as to save the mill extras, but usually they are placed at points of contraflexure or of zero dead-load moments.

DECK PLATE-GIRDER STRUCTURE BUILT IN 1935 FOR LAUDERDALE COUNTY, MISSISSIPPI

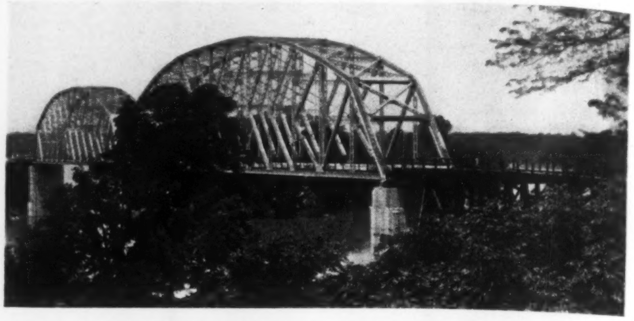
The Over-All Length of the Bridge Is 320 Ft

DEFLECTIONS IN BEAM BRIDGES

Depending on the span lengths, beams for simple-span bridges and for the continuous and cantilever types are usually cambered to compensate for deflection. This adds to the cost of the bridge but also to its appearance—provided the deflection is noticeable. Instead of cambering the beams, some states compensate for deflection and obtain a level roadway by increasing the slab thickness over the beams. Since the mills will not guarantee to provide camber to a tolerance less than $^3/_8$ in. plus or minus, the latter method has proved a better solution in a great many cases.

Lack of rigidity and excessive deflection under live load are objections that have been made to these types of bridges. Deflection under live load is minor in extent, but should be kept within reasonable limits. Although noticeable in many cases, it will cause no ill effect if provision for it is made in the roadway slab during construction. Most highway engineers realize this, and very few cracks ever show up in a well-designed roadway slab. On federal-aid projects, however, government engineers have placed a limit on deflection which in some cases has caused states to increase the weights of their designs as much as 10 per cent.

Adjustment of reactions for small settlements is not considered necessary for continuous-beam spans. The reasons are that (1) the beams are comparatively limber, and (2) the splices are located at or near the points of zero dead moments, eliminating the possibility of unknown moments or shears being locked up in them. Slight settlements of supports do not change the reactions, moments, or shears to any great extent.



THROUGH RIVETED-TRUSS BRIDGE ERECTED FOR WARREN COUNTY, MISSISSIPPI, IN 1926, CONSISTS OF TWO 350-FT SPANS

Following the same general plan for pier spacing and over-all length, some highway departments are using deck plate girders with curved bottom chords instead of beams. The plate girders are more expensive than the beams, but the curved bottom chords give a more pleasing appearance, and deflections can be reduced by increasing depths over piers. Since such depths are not limited, as is the case with beams, longer spans are practicable.

A number of bridges of the same type, but employing low trusses and longer spans, have been built in recent years. Experience has shown that continuous steel beams, deck plate girders, and low deck-truss bridges represent a saving of 10 to 30 per cent over simple-span structures. The saving in erection alone may amount to $15 per ton. Rolled beams are economical for central spans of up to 105 ft, plate girders from 105 to 150 ft, and low trusses from 150 to 200 ft.

In addition to the saving in initial cost of construction effected by resting the roadway slab directly on the beams, girders, or trusses, there are other advantages of this type over the half-through or through truss bridges. These include ease of erection, and ease with which the bridges can be widened to provide additional roadway. Furthermore, such spans can be skewed easily and have a high salvage value, whereas skewed truss spans are complicated and expensive.

Esthetic treatment of the external line and form of bridges should be considered by the engineer whenever possible. The trend in recent years has been in this direction and many beautiful structures have been built. In an article published in CIVIL ENGINEERING for February 1932, the late Frank P. McKibben, M. Am. Soc. C.E., expressed this thought as follows:

"A bridge should be something more than a means of overcoming an obstacle. Besides utility, it should possess beauty and permanence. It will express the character and individuality of the designer, and if he is of artistic temperament, his creation will have a charm and loveliness that will appeal to the sense of beauty of all who view it—will even create such a sense where none exists. Not only will such a bridge span chasms for the convenience of man but it will satisfy his longing for a better and more beautiful environment."

Flood Control at Chattanooga

Local Protection Works, in Conjunction with TVA Improvements, Promise Security

By E. Lawrence Chandler

Member American Society of Civil Engineers

Chief Estimator, Tennessee Valley Authority, Knoxville, Tenn.; Formerly Chief Engineer, Chattanooga Flood Protection District, Chattanooga, Tenn.

In the flood of 1867 more than half the area of the city of Chattanooga was inundated. Since this flood represents only about 60 per cent of the probable maximum, the city is urgently in need of some form of flood control. The dams to be built upstream by the Tennessee Valley Authority will provide a material part of the control necessary. If properly developed these dams will make it possible for the city to achieve complete security by means of local protective works which can be built at a justifiable cost. The plan for such works, developed by Mr. Chandler as chief engineer of the Chattanooga Flood Protection District, and proposed by the District in cooperation with the Tennessee Valley Authority, contemplates in general building levees and walls and relocating creek channels, together with construction of the necessary sewer lines, flood gates, and pumping stations. The accompanying article, abstracted from an address of October 9, 1936, before the fall meeting of the Tennessee Valley Section, describes graphically the development of this $15,000,000 flood-protection plan. Chattanooga's experience illustrates the extent and difficulty of the problems with which many flood-ravaged communities have recently been faced.

CHATTANOOGA is highly favored in many respects. Enjoying a setting scarcely to be surpassed for scenic beauty, the city has a favorable climate and is a center for railroads, highways, and airways. With the maturity of the navigation program now in progress on the Tennessee River, Chattanooga will become increasingly important as a shipping point. All these factors tend to make the city attractive and desirable as a place of business and residence.

But there is a penalty attached to this beautiful location, due in part to the very features which make it attractive. I refer to the ever-present menace of floods. The city is not unique in this respect, but the combination of circumstances found there is unusual. Chattanooga is typical of other cities lying, without protection, wholly or in part on the flood plains of treacherous rivers, and its situation is of general interest for that reason.

The question arises as to why any city of 120,000 inhabitants should be so seemingly short-sighted as to develop its business and industrial life in areas where it may, in any year, be dealt a blow from which it can recover only with difficulty, if at all. Or, as a corollary, if it persists in building on the flood plain of the Tennessee River, why does it not hasten to provide protection against floods?

Perhaps the answer to the first question is not difficult. It is entirely natural that pioneers in rugged country should select a site for settlement along the banks of a stream. The river affords a source of water and food supply and a means of transportation. Generally, the soil of the flood plain is fertile, offering favorable opportunities for agriculture. Such soil is an accumulation of the best of upstream materials washed down and deposited by floods through the centuries. Again, it is entirely natural that roads and railroads should follow water-level routes as far as is feasible. With increasing growth of population, agriculture and industries naturally center around the transportation facilities, where means of travel and shipment of freight are convenient, and where construction is easier than on the steep slopes of the surrounding hills.

The answer to the second question is not quite so easily found. It relates to the forgetfulness and general optimism of humanity. In the early stages of a community's development, the occurrence of a flood is not likely to result in overwhelming disaster. The community is small, and when a flood alarm is sounded it is no great matter for all those in danger to flee to the surrounding hills for as long as may be necessary. Serious floods may occur only at long intervals, perhaps not once in a generation. The result is that the havoc wrought by the latest great flood often becomes almost a legend before the next one arrives. The citizens think of floods only in terms of the past, and in the meantime building goes on apace and the stage is set for another disaster. Flood-protection works are expensive, and the ever-ready slogan of certain advocates of false economy is that "now is not the time" for the necessary expenditure. Too often adherence to that slogan has resulted in delays until a sudden flood dealt its destructive blow. The flood-protection works then built, combined with the flood damage already incurred, cost double or treble the amount that would have been required had suitable measures been taken in time.

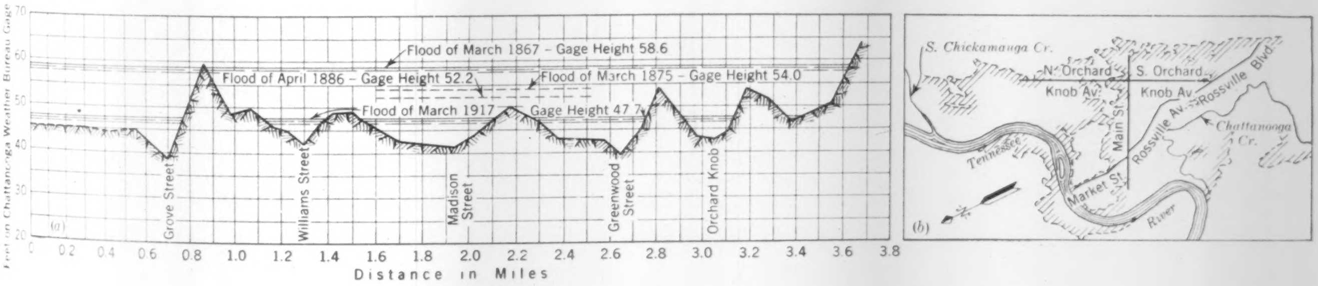


Fig. 1. Flood Depths in Chattanooga During Major Floods

(*a*) Profile Along Main Street; (*b*) Map Showing Area Flooded in 1867

A glance at the profile along Main Street, Chattanooga, shown in Fig. 1 (*a*), is sufficient to indicate the general character of the topography of the flood plain where the business and industrial life of the city is situated. This is a profile approximately at right angles to the river. Most of the business activity of the community is conducted on, or north of, Main Street, while the greater part of the industrial district lies to the south of it, and for the most part at a lower elevation. The profile is typical of a generous part of the less desirable residential area.

Elevations are referred to mean sea level, zero on the river gage being at El. 621.12, as corrected to a 1929 level adjustment. Low-water elevation is at about El. 627.0. Beginning at the river bed, the profile climbs the east bank to an elevation of about 45 ft on the gage, continuing eastwardly along Main Street for a distance of approximately 3.6 miles before rising abruptly up the slope of Missionary Ridge. The highest elevation encountered is about 59 ft on the gage, and approximately one-third of the street is below a stage of 45 ft.

The first flood of which a substantial record exists occurred in 1867. It was also the greatest of record. Coming in March, as a result of long and severe rains, the water rose to a stage of 57.9 ft on the gage and reached a peak flow estimated at about 459,000 cu ft per sec. It will be noted that in 1867 the entire section of Main Street between the river and the foot of Missionary Ridge was under water. The area flooded at this time [Fig. 1(*b*)] was more than half of all that within present city limits. In 1867 the population of Chattanooga was only about 5,000; today it has a population 120,000 and such a flood would be calamitous.

In 1875 there came a flood which reached 53.8 ft on the gage. Next in order of severity was that of 1886, with a gage height of 52.2. Fourth in magnitude was the flood of 1917, with a stage of 47.7. The flood of April 1936 would have risen to something like 41.0 ft if there had not been a reduction of about 4 ft as the result of storage in Norris reservoir.

Flood stage at Chattanooga has been established as 30 ft on the gage. Since 1874, when continuous records were begun, there have been 38 years when floods equaling or exceeding that stage have occurred. Of that number, 11 brought floods in excess of a 40-ft stage. When the 33-ft stage is reached, approximately 10 per cent of the total area of the city is under water. Owing to the width and flatness of the flood plain, the area subject to flooding increases beyond that level at a rapid and fairly uniform rate up to the stage reached by the flood of 1867. Approximately 50 per cent of the city lies below that stage. Above that stage, the rate of flooding decreases rather rapidly, owing to the steep slopes of the surrounding hills. A large part of the area that is affected by a stage of about 35 ft is now unoccupied and of little value, as the land is subject to flooding and occupancy is too hazardous.

In a report dated August 20, 1932, the U. S. Engineer Department estimated that the average annual flood damage at Chattanooga would be approximately $687,000, an amount equal to nearly 40 per cent of all the damage occurring in the entire valley. This sum will increase as the community grows. Scant consideration of the conditions mentioned is necessary to indicate the advisability of flood-protection measures, if protection can be secured at an economically justifiable cost.

WATERSHED HAS RAPID RUNOFF

Geographically, the watershed of the Tennessee River is divided into two approximately equal parts, with Chattanooga about the mid-point. That part of the watershed above the city contains 21,400 sq miles and extends into Virginia, North Carolina, and Georgia. The upstream tributaries have their sources in the mountainous regions of the Great Smokies and the Blue Ridge. The soil is generally clayey and the slopes are steep, providing rapid rates of runoff. Annual precipitation over this part of the watershed varies from about 50 in. to as high as 80 in. The valley is subject to storms of high intensity, the most severe generally occurring in the spring of the year. While heavy snowfall is rare at low altitudes, it is not unusual for snow to accumulate to depths of 2 ft or more in the mountain forests. Thus, a combination of circumstances may occur in any year that will result in a great flood.

The flood of 1867 reached a peak flow at Chattanooga of approximately 430,000 cu ft per sec—an average of 20 cu ft per sec per sq mile from the entire area of the upstream watershed. Careful study by the engineering staff of the Tennessee Valley Authority indicates that, with no reservoir control on the Tennessee and its tributaries, the maximum flood likely to occur at Chattanooga would be 70 per cent greater than that of 1867. Complete security against such a flood by local protection works only would be so great an undertaking that it is probably not economically justifiable. However, the flood-control program of the Tennessee Valley Authority, which includes dams on the upstream tributaries, will result in material reduction of flood flows at Chattanooga and in the lower reaches of the valley. Properly developed, such upstream control will make it possible for the city to achieve complete protection with a justifiable expenditure.

Sufficient data have never been assembled to permit the making of a complete plan and sound estimate of the cost of suitable protection works.

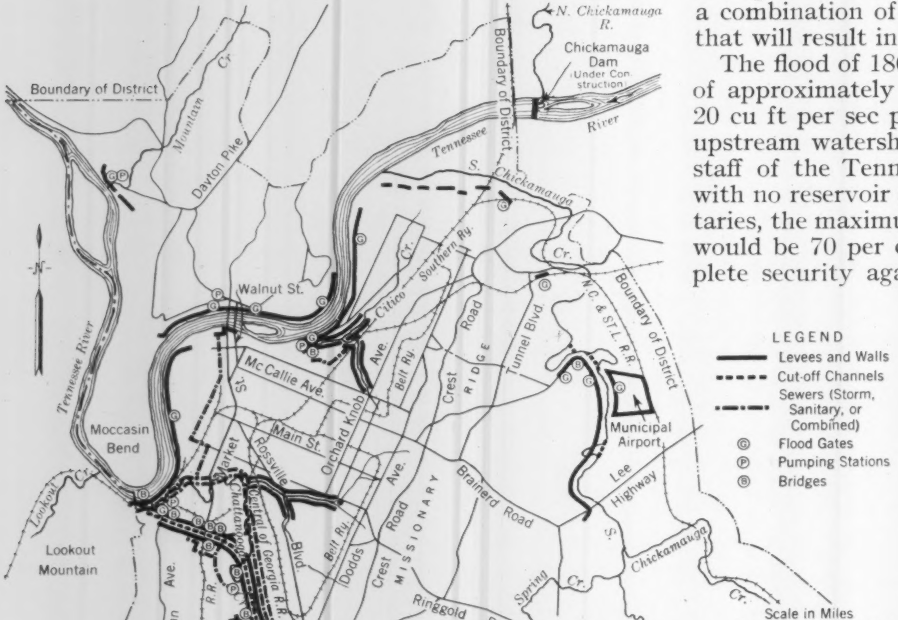

N. Chickamauga R.
Chickamauga Dam (Under Construction)
Boundary of District
Mountain Cr.
Dayton Pike
Tennessee River
Boundary of District
S. Chickamauga Cr.
-N-
Walnut St.
Citico Cr.
Southern Ry.
Cr.
N.C. & St.L. R.R.
Boundary of District
Tennessee River
McCallie Ave.
Orchard Knob Ave.
Belt Ry.
Crest Road
RIDGE
Tunnel Blvd.
Moccasin Bend
Main St.
Market St.
Rossville Blvd.
Municipal Airport
Lee Highway
Lookout Cr.
Chattanooga
Central of Georgia R.R.
Brainerd Road
S. Chickamauga Cr.
Lookout Mountain
Tenn Ave.
T.A.G. R.R.
Belt Ry.
Dodds Ave.
Crest Road
MISSIONARY
Spring Cr.
Ringgold Road
Boundary of District
TENNESSEE
GEORGIA
LEGEND
Levees and Walls
Cut-off Channels
Sewers (Storm, Sanitary, or Combined)
Flood Gates
Pumping Stations
Bridges
Scale in Miles
0
1
2

FIG. 2. MAP OF CHATTANOOGA FLOOD PROTECTION DISTRICT, SHOWING PROPOSED PROTECTIVE STRUCTURES

although sporadic attempts have been made. The community did not seem to become aware of its hazardous situation until the flood of 1917, when forward-looking citizens began to realize that floods should be the object of something more than reminiscence. Committees were chosen, a small sum of money raised, and an engineering study undertaken. The result was a report by the late A. L. Dabney, M. Am. Soc. C.E., in 1919, in which was proposed a program of levee construction, supplemented by pumping facilities to take care of local sewage and creek flow during high water.

With this report as a basis, another was prepared in 1921 by the late Nisbet Wingfield, M. Am. Soc. C.E., and Mr. Dabney. This proposed partial protection for part of the city at an estimated cost of about $10,000,000. Variant schemes proposed protection for smaller areas of the city for about $5,000,000. These reports were necessarily very general and incomplete, the total expenditure for both being only $20,000. They proposed building levees to an elevation of 60 ft on the gage, apparently using the 58.6-ft stage reached in 1867 as a basis for design. It appears that no consideration was given at the time to the probability that the 1867 flood might be exceeded.

Commercial National Bank

BROAD AND EIGHTH STREETS TODAY, SHOWING HEIGHT OF WATER DURING THE 1867 FLOOD

ESTABLISHING A FLOOD-PROTECTION AGENCY

Not only was there no political subdivision or agency found which was endowed with suitable power to undertake and carry out a program for flood protection, but there was no statute in the state of Tennessee under which such work could be properly conducted. After ineffectual attempts in 1921 and 1923 to secure legislative authority, the Chattanooga Protection District was legally constituted in 1929. But it was not until 1935 that engineering studies were begun in earnest on the re-named "Chattanooga Flood Protection District."

In the meantime the Hamilton County Regional Planning Board has come into being and is undertaking to direct the development of the region in general.

Concurrently with these local activities, an extensive study was conducted by the U. S. Engineer Department of the water resources of the Tennessee Valley and their development. This work was undertaken in 1921 and continued until it became a part of the duties of the Tennessee Valley Authority, when it was organized in 1933.

Any proper approach to a solution of Chattanooga's flood problem must be founded on an understanding of the hydrology of the entire upper watershed. It is only by determining the effect of the flood storage to be developed in the proposed reservoirs on the upper river and its tributaries that a measure of the protective work necessary at Chattanooga can be obtained.

The program of the Authority will eliminate nearly all damage by lesser floods and will provide a large degree of control for floods of great magnitude, but local protection works must be constructed at the various communities if they are to be free from flood danger.

The need today is for a feasible plan which, supplementing the control furnished by the upstream dams, will give full protection to such areas within the boundaries of the District as merit protection, at a cost that is economically justified.

LOCAL STREAMS AGGRAVATE DIFFICULTIES

Chattanooga's problem is not simply one of securing protection against floods originating on the upstream tributaries of the Tennessee River. The situation is complicated by several streams which enter the main river either at or near the city (Fig. 2). The largest of these is South Chickamauga Creek, which drains an area of approximately 450 sq miles. Its watershed extends in a southerly direction about 35 miles to a point south of Lafayette, Ga. The creek empties into the river just upstream from the city limits. Citico Creek, draining 5 sq miles entirely within the boundaries of the city, joins the river about one mile upstream from the Walnut Street bridge.

Chattanooga Creek, with a watershed of about 80 sq miles, extends 15 miles to the south along the eastern side of Lookout Mountain. It follows a tortuous course nearly eight miles long through the southern part of the city area. Also included within the boundaries of the Chattanooga Flood Protection District is a considerable part of the valley of Mountain Creek, which joins the river from the north at a point about a mile upstream from the foot of Signal Mountain. This area is downstream from, and almost entirely outside, the city limits.

All these creek valleys are subject to high rates of runoff, and are apt to develop floods of considerable magnitude quite independently of those on the main river. This is particularly true of Chattanooga Creek and South Chickamauga Creek. In the spring of 1936, at a point approximately eight miles from the Tennessee River, South Chickamauga Creek reached an elevation 20 ft higher than the corresponding river elevation at its mouth, with the result that the municipal golf course and airport were flooded, together with extensive surrounding areas. This condition was partly due to the winding course of the creek bed, but was aggravated by natural growth and by the presence of railroad bridges and other artificial obstructions downstream from the airport.

A further complication is found in the fact that domestic sewage and trade wastes are discharged into the streams. Sewage from a considerable area in the southern part of the city requires pumping at low-water stage for discharge into the river near the mouth of Chattanooga Creek. Long before the so-called "flood stage" is reached, the pumping station becomes inoperative and all the raw sewage is discharged into the slack flood waters. Any solution of the flood problem will require the construction of large pumping facilities to care for sewage and local storm-water flowing during periods of high water.

Although sufficient data are not available to permit development of a sound and complete plan, it may nevertheless be of interest to consider the general features of the plan suggested by the Chattanooga Flood Protection District, for it seems probable that the eventual plan will resemble this one in the main.

THE FLOOD PROTECTION DISTRICT'S PLAN

Principal features of the proposed plan are indicated in Fig. 2 by the character of the heavy lines—solid ones denoting either earth levees or concrete walls; dotted ones, relocated creek channels; and dot-and-dash lines, sewer construction. Flood gates are indicated by a circled *G* and pumping stations by a circled *P*.

VIEW ON THE LEE HIGHWAY, U. S. ROUTE 11, EAST OF THE CITY
The Arrow Shows the Height of the 1867 Flood

Levees are to be constructed along the banks of the Tennessee River for the protection of such areas as have sufficient value to warrant the necessary outlay. On the left bank, looking downstream, the levee would begin at a knoll just below South Chickamauga Creek and extend to high ground about a mile upstream from the Walnut Street bridge. Beginning again between the Walnut Street and Market Street bridges, a levee and concrete wall would extend south and east across Chestnut Street to the slope of Cameron Hill. Leaving a small area between the hill and the river unprotected, the levee would begin again and continue downstream, generally parallel to the river bank, to tie into the foot of Lookout Mountain.

On the right bank, the area upstream from the Chattanooga Golf and Country Club does not appear to warrant protection. Beginning at the club grounds, a levee would be carried downstream along the river bank to join Stringers Ridge. There is little development in the area known as Moccasin Bend, and no protection has been contemplated there. In the Mountain Creek Valley there is considerable valuable property which could be protected by a short levee running across the mouth of the valley as indicated. A flood gate and pumping station would be required for the control of the creek flow.

Along the left bank of South Chickamauga Creek, looking downstream, there would be levees to protect the low areas from a point above Lee Highway to the mouth of the creek. The airport bordering on the right bank of the creek is already surrounded by a levee, which would be enlarged. Several sharp curves in the present course of the creek would be eliminated by cutoff channels, and the capacity of the channel would be increased by removing obstructions to flow.

There would be levees along both sides of Citico Creek to a height sufficient to protect the adjacent area against a flood stage of 25 ft without the necessity of pumping. Flood gates at the mouth would be closed for higher stages and a pumping station would be required near by to care for sewage and local drainage. The dotted line represents an intercepting sewer leading to the pumping station.

Chattanooga Creek presents one of the most troublesome problems. Under the proposed plan the channel would be relocated between a point near the Tennessee-Georgia state line and its mouth, materially improving the alignment and shortening the length. Levees on both sides of the creek would be built to the full height necessary for protection against maximum backwater stages from the river and from local floods originating in the watershed of the creek. These levees would be carried to high ground on each side of the valley on the Tennessee side of the state line. A short levee and pumping station would be necessary at the south end of the St. Elmo area, located in the southwest corner of the city.

Having thus confined Chattanooga Creek between levees in its new channel, there would remain the necessity for disposing of sewage and local storm flow from about 12 sq miles of drainage area lying downstream from the intake of the new channel. This would require extensive construction of storm and sanitary sewers and a large pumping station near the mouth of the creek.

The program would include very considerable items of railroad, highway, and street relocation; bridge construction; flood gates on some 20 sewer outlets; a number of small pumping stations in locations other than those mentioned; and a variety of other work throughout the District. Aside from the protection gained for present property, a highly desirable result of flood protection would be the reclamation of large areas of now useless land which is excellently located for industrial sites except for the existing flood hazard. This is especially true in the Chattanooga Creek region. At some added cost it would be possible to locate highways on the tops of some of the levees, resulting in improved approaches to the city and affording a scenic drive in connection with the park system.

Obviously, the cost of any system of local protection works depends upon the height to which it must be built, and that height, in turn, depends upon the amount of reduction in flood stage which will result from the flood-control works of the Tennessee Valley Authority. Until the amount of that reduction is definitely established, an accurate cost estimate will not be possible.

TENTATIVE ESTIMATE OF COST

Before filing an application for federal aid it was necessary for the Chattanooga Flood Protection District to prepare an estimate of cost based on such data as were available. Therefore, it is tentatively assumed that a flood stage of 56 ft on the gage would be a proper basis, and on that assumption it was estimated that the total cost of the program outlined would be approximately $15,000,000. Although it should be borne in mind that this sum may be subject to considerable modification either upward or downward, it is indicative of the magnitude of the project.

Flood protection for Chattanooga will be an expensive undertaking, but all available estimates of the benefits to result from it indicate that it will be a sound investment. Benefits, tangible and intangible, will mount far beyond such a sum as that stated.

It is earnestly to be hoped that protection will be found possible within reasonable cost and that it will be achieved, so that Chattanooga may be assured of a prosperous future, secure in the knowledge that the river will always be a useful servant, powerless to cause such damage and loss of life as have occurred recently in various parts of the country.

ENGINEER'S NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Hydraulic Models Used in Design of Parker Dam

By S. PERLITER, ASSOC. M. AM. SOC. C.E.

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IN the design of Parker Dam, hydraulic models were called upon to answer a variety of questions. Primarily, it was expected that the tests would indicate which type of dam—arch or gravity—was better suited to the operating conditions. In addition, attention was given to determining: (1) The proper shape of the overflow crest, (2) the most favorable location of the power plant, (3) the most desirable operating conditions of the gates, and (4) the best shape for the entrance approach to the gates. The model was constructed on a scale of 1:80. In what follows, dimensions and quantities will be stated in terms of the prototype.

GRAVITY DAM MODEL

The gravity dam consisted of an overflow section surmounted with seven 50 by 50-ft Stoney gates. It was tested first with the crest profile shown as No. 1 in Fig. 1. For discharges greater than about 115,000 cu ft per sec there was considerable disturbance downstream from the dam, in the form of waves and eddies. This was probably due to the submergence of the crest and to the fact that the water in leaving the crest was directed parallel to the stream bed. The turbulence was dissipated against the steep banks of the river on the Arizona side (left bank) and against the face of the power plant on the California side.

To eliminate these undesirable conditions, the crest was changed to profile No. 2, later to No. 3, and finally to No. 4. As the crest slope was made increasingly steep, and the flow was consequently directed more and more downward into the pool below the dam, the waves were decreased in size. An accompanying pair of photographs illustrates clearly the improvement in flow conditions resulting from the change in crest profile.

During this series of tests the flow was discharged through all seven gates; however, as the experiment progressed, various combinations of two or more gates were tried. It was found that discharging large quantities through the seven gates created considerable disturbance near both banks. By shutting the gate adjacent to each bank the turbulence was considerably reduced. For discharges up to about 50,000 cu ft per sec, the two center gates can be used alone with good results; however, for discharges greater than 50,000 cu ft per sec, the center five gates should be utilized, with equal openings to properly handle the flow.

Of the two power-plant locations investigated, the more desirable was the one nearer the dam. The more distant location was undesirable not only on account of the increase in length of the penstock tunnels, but because of the pronounced eddies farther downstream.

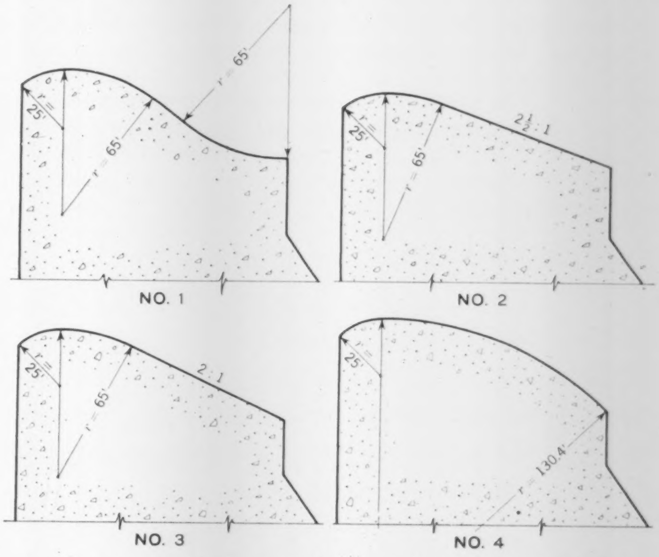
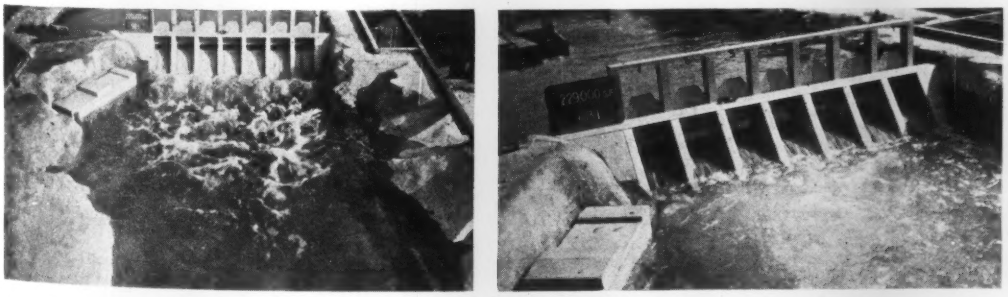


FIG. 1. CREST PROFILES USED IN GRAVITY DAM MODEL

ARCH DAM MODELS

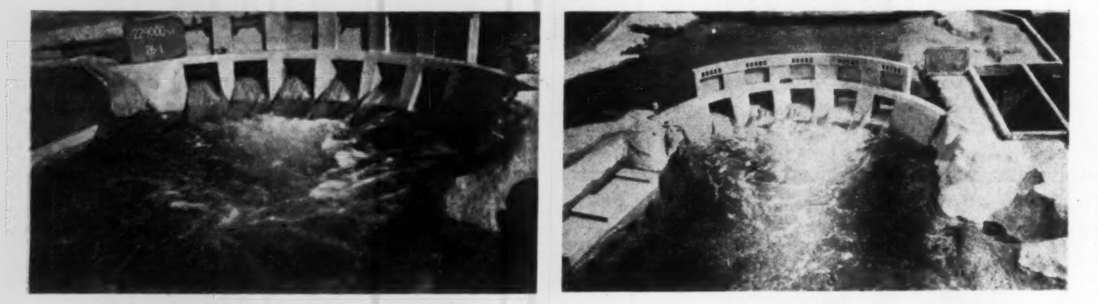
Two models of arch dams were tested. The crest of the first model directed the flow of water over the dam parallel to the river surface, while in the second model the crest was so altered that the discharge through the gates was directed downward, into the pool below (Fig. 2). The power plant was moved from time to time to determine the most desirable location.

On the first arch-dam model, under all conditions of discharge, a decided surging and turbulence occurred in front of the downstream face of the dam and around the power plant. As the discharge increased, considerable erosion was noticeable near the upstream corner of the power plant and along the adjacent banks.



Turbulence Caused by Use of Crest Profile No. 1 Smooth Flow Produced by Crest Profile No. 4

THE GRAVITY DAM MODEL, SIMULATING A FLOW OF 229,000 CU FT PER SEC



Turbulence Caused by Use of Crest Profile No. 1 Improved Conditions with Crest Profile No. 2

THE ARCH-DAM MODEL, SIMULATING A FLOW OF 229,000 CU FT PER SEC (SEE FIG 2)

Under normal operating conditions, any flow not passing through the power plant can be discharged either through two gates situated near the extreme ends of the dam or through all the gates. There was very little choice between either of these methods of operation.

Directing the flow through the gates towards a common center aggravated the conditions downstream from the dam as compared with the conditions of flow observed in tests of the gravity dam of similar crest design. However, it was believed that the additional disturbances could be permitted at the center of the stream without any appreciable danger, and the arch dam was selected for the final design because of its relative economy. In the second arch-dam model, the flow disturbance was reduced to a minimum by changing the shape of the crest.

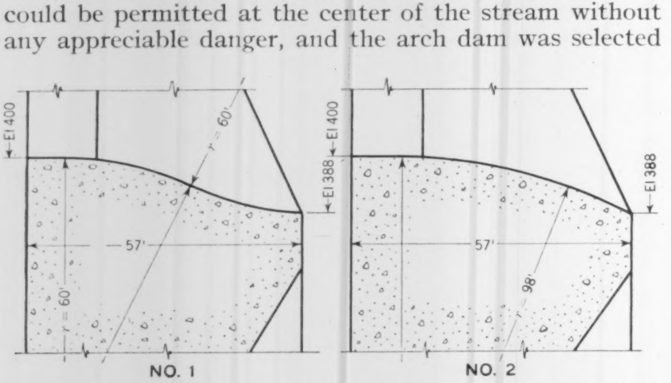


FIG. 2. CREST PROFILES USED IN MODEL TESTS OF ARCH DAM

During high discharges the flow through Gate No. 1 was quite turbulent, because of the restricted area near the upstream face of the dam on the Arizona side. This turbulence was reduced by moving all the gates radially towards the California side about 25 ft, or half the gate width. However, after this change, a peculiar noise was detected near the California abutment. This noise was evidently caused by a slight vacuum pocket which formed at the downstream face of the dam near Gate No. 5 and was attributable to the crowded flow condition near the California side. There was a noticeable backwash, which apparently caused this restricted action near the gate. Finally, therefore, the gates were moved back towards the Arizona side, and a free approach to Gate No. 1 was assured by removing some of the adjacent hillside.

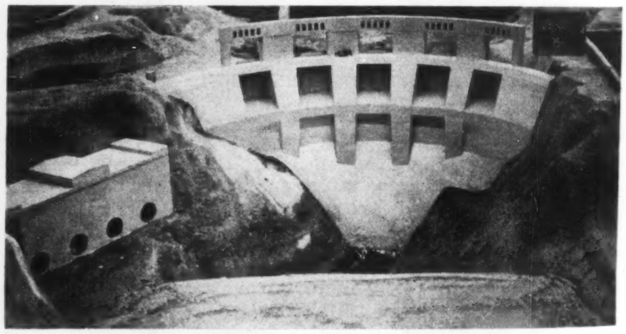
As with the gravity dam, it was found that all gates when possible should be operated with equal openings. Unequal openings produced cross currents and excessive wave action.

GATE ENTRANCES

In the original models, the entrances to the gates were made square. Later three types of curved entrances were tested: (1) Using a curve of 5-ft radius, (2) using a curve of 10-ft radius, and (3) using a semicircular pier nose.

As was anticipated, the larger the rounding of entrances to the gates, the greater was the discharge through them. However, since the maximum flow will occur extremely infrequently, and since a semicircular pier nose would materially increase the cost of the dam, it was suggested simply that the radius of rounding the gate entrances be made as large as is economically possible.

I performed the tests here described under the direction of Julian Hinds, M. Am. Soc. C.E., assistant chief engineer of the Metropolitan Water District of Southern California.



THE PARKER DAM MODEL, UNWATERED

The Work of the British Steel Structures Research Committee

By ROBINS FLEMING

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The three reports of the British Steel Structures Research Committee, of which the final one was issued in 1936, contain considerable food for thought for American engineers. Dr. Fleming here presents a brief review of these reports, which should be of especial interest to those engaged in building design.

THE British Steel Structures Research Committee was appointed in August 1929, (*a*) to review present methods and regulations for the design of steel structures, and (*b*) to investigate the application of the modern theory of structures to design, and to make recommendations for the translation into practice of such results as would appear to lead to more efficient and economical design.

The first report of the committee (276 pages) was issued in 1931, the second report (369 pages) in 1934, and the third and final report (572 pages) in August 1936. The names of the eminent contributors assure a high degree of scholarship. Sir Clement D. M. Hindley, the chairman, has stated that he does not think any investigation of the past fifty years has been of more importance to the engineering profession or has tended to affect so directly the work of engineers engaged in design.

At the beginning of work the following items were selected for serious consideration: (1) Loads on floors, (2) strains in buildings, (3) stress analysis, (4) specifications and properties of materials, (5) welded connections, and (6) vibrations.

THE FIRST REPORT

An extended investigation and a comparison with codes of other cities led to the "Recommendation for a Code of Practice." A drastic reduction was made in the superimposed floor loads of the existing code. For instance, floors for domestic purposes, hotel bedrooms, and the like, may be designed to carry 40 lb instead of 70 lb per sq ft, and the upper floors of offices to carry 50 lb instead of 100 lb. All floors except those scheduled for 40 lb per sq ft are to be capable of carrying a prescribed alternative concentrated load. A reduction, according to schedule, of superimposed loads is allowed in calculating the total loads on pillars, walls, and foundations. The assumed wind pressure is not to be less than 15 lb per sq ft on the upper two-thirds of the vertical projection of the building, with an additional pressure of 10 lb per sq ft on all projections above the general roof level. On the seacoast and similarly exposed situations, a further provision, not exceeding 10 lb per sq ft, is required. If the height of a building is less than twice its average width, wind pressure in general may be neglected, provided that the building is adequately stiffened by floors and walls.

Working stresses for steel may be summarized as follows:

For parts in tension—on the net section for axial stress or extreme fiber stress of all beams, 8 long tons (1 ton = 2,240 lb) per sq in.

For compression flanges of beams—on the gross section for extreme fibers of beams solidly encased in a concrete floor or otherwise laterally secured, 8 long tons per sq in. Working stresses in grillage beams entirely embedded in concrete foundations may exceed those otherwise specified by 50 per cent.

For parts in shear—on the gross section of webs, 5 long tons per sq in.; on shop rivets, 6 long tons per sq in., and on field rivets, 5 long tons per sq in.; on black bolts, where permissible, 4 long tons per sq in.

For parts in bearing—on shop rivets, 12 long tons per sq in.; on field rivets, 10 long tons per sq in.; on black bolts, where permissible, 8 long tons per sq in. "Right fitting turned" bolts are allowed the same value in shear and bearing as shop rivets.

For an increase of stress due solely to wind pressure, the usual working stresses may be increased $33^1/_3$ per cent.

The allowable stress in columns is determined by the ratio of effective length to the least radius of gyration. Values for ratios of 20 to 240 are given in a table. The section on columns ("pillars" or "stanchions" in English parlance) as quoted in R. A. Skelton and Company's handbook, *Steel Construction*, is prefaced by "not too easy to interpret in practice." Professor J. F. Baker in the final report says, "These clauses as they stand are all valueless. . . .It was found that the exact expression for the effective length of a pillar in a frame was too complex to be used generally in practice, and attention was directed to the derivation of a safe though approximate rule simple enough for design purposes."

LATER REPORTS

The second report states that the "Recommendations for a Code of Practice" were adopted in February 1932, practically unchanged, by the London County Council as the basis of considering applications for relief from certain provisions of the Building Act. They were embodied in the British Standard Specification No. 449 issued in April 1932 by the British Standards Institution. The report also states, "We understand that the adoption of the new code has led to a reduction amounting to as much as 20 per cent in the cost of steelwork required for the kind of building to which it mainly relates."

In the second and third reports, "the main items of investigation may be grouped under four headings: the measurements of strains in existing buildings; the examination of bolted and riveted connections; stress analysis, both mathematical and mechanical; and the study of new methods of design." Great attention is given to the first item. Tests were made on the steel frame of a museum building in South Kensington both before and after the steel was encased in concrete (discussed in the second report). Tests made during the erection of three other buildings to determine stress distribution are discussed in the final report. "Strain measurements were made at a number of sections of the steelwork when certain beams of the bare frame were loaded, again after the floors had been placed, and finally after the walls and stanchion casing had been built."

Professor C. Batho gives considerable attention to beam and column connections in a paper in the second report and to bolts and bolted joints in a paper in the final report.

One of the concluding papers gives an elaborate analysis of the effect of wind loads on frames with semi-rigid connections, and a method of calculating stresses therefrom. The conventional "portal" and "cantilever" methods are, to put it mildly, not approved. In writing the paper, Professor Baker evidently did not have in mind the tall buildings of America. Few buildings in Britain, according to code requirements, need provision for wind stresses in the steel frame. When so needed it is advised that special bents be designed to resist the whole wind shear.

Throughout the three reports it is emphasized that present methods of distributing stress in steel-framed buildings are decidedly erroneous. Errors "are inherent in the assumption made when considering vertical loads that the framework consists of vertical stanchions with horizontal beams pin-jointed to them." Again, "The critical part of a structure of the type examined is the connection between a horizontal and vertical member. It has been realized that this connection must be considered to behave as a unit and that the stresses in the various parts cannot be estimated by conventional methods."

It is obvious that if floor beams are restrained at their ends, intermediate bending moments will be decreased and lighter sections may be required than if ends are simply supported; on the other hand, column sections will theoretically be increased. The magnitude of all moments will depend upon the degree of restraint, which is governed by the kind of connection employed between beam and column. The scores of pages given to the design of beams, columns, and connections are not easy reading, and the "translation to practice" is at times difficult.

The reports culminate in "Recommendations for Design." Only vertical forces are considered. As previously mentioned, lateral forces need seldom be considered in the design of the steel frame of buildings in Britain. In the design of beams, a striking innovation is the classification of connections of beams to columns. Four classes are recognized, and in a paper by Professor Batho the varying values of these types are illustrated by specific examples. Rules and tables are given for the determination of restraining moments.

As for the design of columns, tables are given for determining the total bending moment due to live load and to dead load, in the bottom, intermediate, and top lengths of a multi-storied column. A reduction of live loads, according to table, is allowed for floors below that of the topmost story except on those scheduled for an applied loading of 100 lb or more per sq ft. An increase of section in determining the axial load per square inch is allowed for unpainted steel columns encased in 1:2:4 (or stronger mix) of reinforced concrete if certain provisions are met.

"The new rules," says the report, "do not in themselves comprise a complete new code of practice. They can, however, be incorporated in any code based on the recommendations given by the committee in their first report by modifying certain clauses.... The new rules taking the rigidity of the connections into account are entirely novel."

The structural engineer cannot fail to be impressed by the painstaking investigations described in such detail in the three reports. The proposed methods of design will appeal to him as giving results nearer the actual than current methods. They are worthy of serious study and should not be cast aside until their workability is determined.

Welding High Tensile Steel

By E. W. P. SMITH

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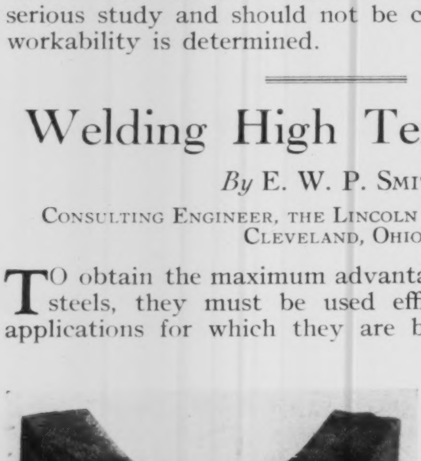
CLEVELAND, OHIO



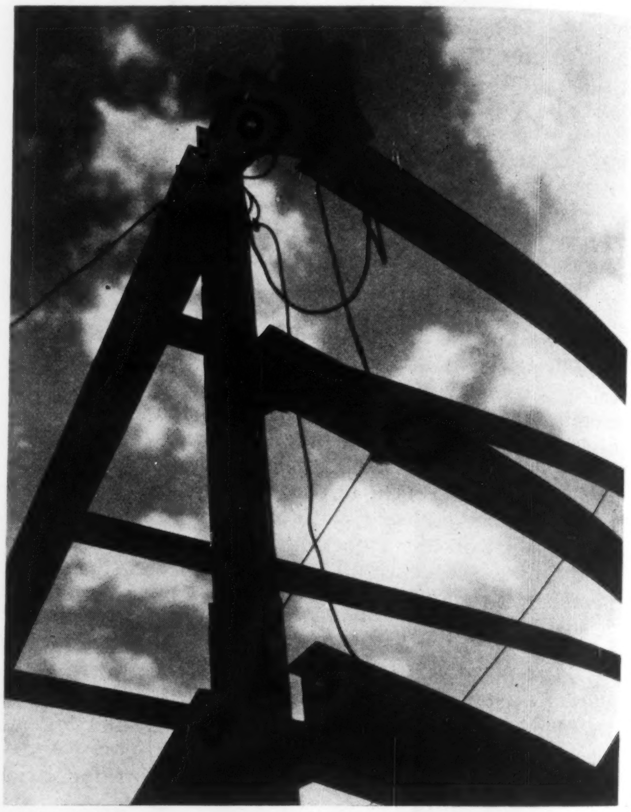
Lincoln Electric Co.

FIG. 1. FREE-BEND TEST OF ELECTRIC WELD IN HIGH TENSILE STEEL

TO obtain the maximum advantage from high tensile steels, they must be used efficiently, that is, in applications for which they are best suited. For the same structural shapes, the deflection for a given load will be the same whether a high tensile or low tensile steel is used; the advantage in the use of high tensile steel results from utilizing different structural shapes, higher unit stresses, and reduced weights. It is obvious that a structure built of such steel may be sufficiently strong while having a deflection somewhat greater than that ordinarily permissible. The exact amount of deflection will, of course, be dictated by the design.

The use of high tensile steels generally results in the use of sections of lesser area; consequently the sections are thinner. This is permissible because of the steel's high resistance to corrosion.

High tensile steels are made in a number of different alloys, most of which are rather low in carbon content and easy to weld. With the proper type of electrode and careful workmanship, welds with physical characteristics similar to those of the steels themselves can readily be obtained at moderate cost.



Lincoln Electric Co.

ARC-WELDING—A PHOTOGRAPHIC SILHOUETTE

The high quality of results obtainable is illustrated by the free-bend test specimen shown in Fig. 1. The test showed a ductility of 86 per cent elongation in the outer fibers of the weld. Attention is called to the plastic flow of the metal on the inner side of the bend.

Two types of electrode are available for welding high tensile steels. Both are heavily coated and of the shielded arc type. One of them is designed for use with low carbon nickel steels, structural silicon steels, and in general, all low-alloy steels with a carbon content of less than 0.30 per cent.[1] On such steels, the electrode has produced welds with the following properties:

Ultimate tensile strength, 85,000 to 100,000 lb per sq in.
Yield point, 60,000 to 70,000 lb per sq in.
Ductility (elongation in 2 in.), 15 to 20 per cent
Impact resistance, 60 to 75 ft-lb (Izod)
Fatigue resistance, 45,000 lb per sq in.
Density, 7.82 to 7.86 grams per cc

The second type of electrode was developed for use with steels having somewhat higher ultimate strengths than those in the preceding group. On these steels, welds with the following properties have been obtained.

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[1] **Some authorities, in considering the welding of alloy steels in general, not subject to preheating or postheating, have placed the maximum carbon limit as low as 0.15 per cent. See PROCEEDINGS for October 1936, page 1200, last paragraph.**

As welded:
  Ultimate tensile strength, 100,000 to 105,000 lb per sq in.
  Yield point, 90,000 lb per sq in.
  Ductility (elongation in 2 in.), 12 to 15 per cent
  Fatigue resistance, 55,000 lb per sq in.
Stress relieved:
  Ultimate tensile strength, 110,000 to 115,000 lb per sq in.
  Yield point, 90,000 lb per sq in.
  Ductility (elongation in 2 in.), 15 to 20 per cent

The procedure in welding high tensile steels is in general the same as that applicable to plain carbon steels. Current of positive polarity is used—that is, the electrode is positive and the work negative. When welding in a flat position, the arc voltage ranges between 24 and 28 v and, in some cases, over 30 v. In general, currents approximately in the middle of the range given in the following tabulation should be used:

$^{5}/_{32}$-in. electrode	90 to 175 amp
$^{3}/_{16}$-in. electrode	140 to 225 amp
$^{1}/_{4}$-in. electrode	180 to 325 amp
$^{5}/_{16}$-in. electrode	250 to 400 amp

When welding in the vertical or overhead position, the $^{5}/_{32}$-in. electrode is generally used. However, the $^{3}/_{16}$-in. size is used for finish beads on heavy plate. On vertical joints, the operator should start at the bottom, building up a shelf of weld metal, and weaving the electrode from side to side for the full width of the joint. In overhead work the weld should be made with several narrow beads; each bead should be entirely cleaned before applying the next. Recommended current for vertical or overhead welding is as follows:

$^{5}/_{32}$-in. electrode	100 to 160 amp
$^{3}/_{16}$-in. electrode	125 to 180 amp

Errata

In "Discharge Area of Circular Gates," by I. Nelidov, Assoc. M. Am. Soc. C.E., in the Engineers' Notebook section of the March issue, the following corrections should be made:

In the fifth and sixth lines below the figure, change 1.31 to 0.93 in the three places it occurs.

In the first equation, dy and dy_1 should be outside the radical signs.

In the fourth line from the bottom, "y_{01}/R_1 by k_1" should read "ny_{01}/R_1 by k_1."

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Present and Future of Power

To the Editor: In his article on the "Future Course of the Power Division," in the March issue, Ford Kurtz, M. Am. Soc. C.E., has called attention to the fact that three of the Founder Societies—Civil, Mechanical, and Electrical—have special interest in the subject of power. He then asks the following question: "Is it desirable to attempt to define and then limit our Division activities to that portion of the field which decidedly lies within the province of civil engineering, namely, hydroelectric power minus its technical electrical features? If not, how far should the Division interest itself in those sections whose details admittedly pertain to mechanical or to electrical engineering?"

The first alternative would definitely exclude any consideration of steam plants. I believe that Mr. Kurtz is not—and I am sure that I am not—in favor of that alternative, because he later proposes a power cost committee, which is to collect data on the cost of both hydroelectric and steam power.

In attempting to answer Mr. Kurtz's question, I suggest that our field of activity should be limited to the economics of all methods of power production, but that considerations of design and construction details should be confined to the civil engineering features of power development.

A distinction between the activities of the Technical Divisions of the Society cannot be made so easily. In fact, it cannot be made at all. For instance, the subject of dams is vital to no less than five Divisions—that is, the Power, Irrigation, Sanitary, Waterways, and Soil Mechanics and Foundations Divisions. It is not to be supposed that four of these Divisions would consent to release the entire activity in a given subject to a fifth Division. On the other hand, to avoid duplication of work, there should be some method by which special committee work on a given subject can be allocated to one Division with committee representation from the other interested Divisions.

There appears to be every indication of a return to prosperity in this country. If the present improved conditions continue, there should be renewed activity in all the Divisions of the Society. Whether or not this happy condition will extend to the Power Division will depend largely upon future activities in the field of hydroelectric power developments. The use of such developments in the future will depend principally upon the true cost or value of hydroelectric power.

I am glad to second Mr. Kurtz's proposal for a committee on power cost. Many executives, through lack of a true knowledge of the proper field for hydroelectric power, have ceased to plan seriously for such power in the future. Although much of the best water power has been developed, there are still a large number of undeveloped resources which can and should be used economically.

It is my opinion that the future use of hydroelectric power in this country, particularly by private organizations, could to a considerable extent, be guided by such a committee. I believe very definitely that, unless the subject of hydroelectric power is presented quickly in its true light, there will be very little increase in its use. This, of course, would mean the decay of the Power Division.

William P. Creager, M. Am. Soc. C.E.
Consulting Engineer

Buffalo, N.Y.
April 28, 1937

The Artistic Design of Water Towers

To the Editor: The Pagoda Water Tower at Yenching University, Peiping, China, which is shown on the Page of Special Interest for March, is a remarkable structure and well worth bringing to the attention of all engineers.

In this connection I should like to call to the attention of your readers the design of the administration building at Randolph Flying Field in San Antonio, Tex., shown on page 231 of the same issue. In order to solve the difficult problem of water pressure without an unsightly water tower, the water tower was included in the upper part of the building.

Oscar A. Seward, Jr., M. Am. Soc. C.E.
Resident Engineer, Texas State
Highway Department

Groesbeck, Tex.
April 22, 1937

Sewer Maintenance in Glendale, Calif.

To the Editor: I find the paper on sewer maintenance by Raymond R. Ribal, Assoc. M. Am. Soc. C.E., in the March issue, a helpful addition to available information on this subject. Proper maintenance and the keeping of adequate records will without doubt increase the efficient operation of a sewer system. A record of repairs will also show where the cost of maintenance is so high that replacements should be made.

As Mr. Ribal points out, the value of publicity in connection with this type of work is great. It is lack of knowledge of the importance of proper maintenance that causes fiscal officers and legislative bodies to cut the budgets for such work to the point where it is impossible to operate a sewer system efficiently. A carefully planned campaign of publicity will do much to offset such unwise efforts to economize. It is not always possible to carry on a spectacular test, such as was conducted in the City of Los Angeles outfall sewer. But, through the medium of the press or public addresses, there are many opportunities to show the citizens of a community the importance of their sewer system from a health and business standpoint.

In Glendale we are not ready to abandon our flush tanks, as seems to be the practice in the cities of northern California. We still believe that the cleaning and ventilating effect of the tanks justifies their existence. We also find that the ability to turn a considerable volume of water into the lines during the cleaning out of tree roots greatly aids the men in their work. At the present time we have in operation 727 flush tanks, of which 293 are automatic and 434 manually operated.

Our greatest cause of trouble is from tree roots. Casuarina trees are the worst offenders, while the eucalyptus and poplars divide honors for second place. Pepper, camphor, and oak trees are next, and acacias, the cypress, pines, and palms are also among the trouble makers. When new trees are being planted on the streets, we ask the park department to choose a species other than these. Mr. Ribal's suggestion that a hydrostatic test be applied to every new sewer line before its acceptance by the city is a good one. However, this has not been done up to the present time in Glendale.

It is the policy of this city to run the house-connection sewers into the curb line at the time the main in the street is laid. If the curbs are in place, a double cross is chiseled into the curb and an accurate measurement taken of its position with relation to the next manhole downstream. If the curbs are not in place, a galvanized wire is tied around the end of the house connection. The wire should be cut long enough to allow it to be brought to the surface and tied around a stake marking the position of the end of the pipe. Even if the stake is broken off or lost the wire can always be found and the pipe easily located. This is an inexpensive and very effective way of marking the position of the house connections. The inspectors' records are entered upon a set of sectional maps, showing the entire record of connections. The map record has been found more efficient than a card-index system.

A few of the highlights of the Glendale sewer system may be of interest. At present there are 212.27 miles of sewers, and the city is connected with the Los Angeles ocean outfall. We pay our pro-rata share of the cost of disposal, based on meter readings of the amount of sewage turned into their system. For the last fiscal year this bill was $7,317.40 for 2,201.21 million gallons, or a disposal cost of $3.3243 per million gallons. The cost of maintenance for the last fiscal year, not including the bill from the City of Los Angeles for disposal, was $7,508.66. At the end of the fiscal year, there were 14,200 lots connected to the sewer, which is about 57 per cent of the number which had the sewer available. The maintenance is carried on by two crews of two men each, who carry safety lamps with them at all times.

J. C. Albers, Assoc. M. Am. Soc. C.E.
City Engineer

Glendale, Calif.
April 27, 1937

The Engineer in the Field of Power

To the Editor: I should like to comment on the article on the "Future Course of the Power Division" by Ford Kurtz, M. Am. Soc. C.E., in the March issue. Since the two questions propounded concerning the delimitation of Division activities in portions of the power field concern not merely civil engineers but also mechanical and/or electrical engineers, they properly call for a combined answer. I incline towards avoiding any strict definition or limitation of the Division activities, which would restrict them to a province outside of mechanical or electrical engineering. Rather I believe that, intentionally or otherwise, the interests of the several branches of the profession will overlap to a considerable extent. On the other hand, it seems practicable and desirable to emphasize subject matter which is not within the province of either mechanical or electrical engineering.

As to the proposed subject matter of papers to be submitted under the sponsorship of the Division, I have no contrary comment in so far as the technical or engineering subject-matter is concerned. However, I believe that more stress might appropriately be laid upon the economic aspects of power development generally or even upon those of individual projects. The desideratum in this respect would, I think, hardly be met adequately by means of Mr. Kurtz's fifth and sixth proposals for subjects of study by special committees of the Division. The more strictly technical aspects of the work of the engineer in the power field cannot, in actual practice, be separated from economic aspects.

The emphasis upon additional committee work I consider well warranted. The subjects proposed for study—particularly those requiring annual progress reports—are good. I have in mind subjects relating to costs of power, fixed as well as operating, to power station design, and to prime-mover design. In respect of the second and third of these items, it seems to me that emphasis should be laid primarily upon hydroelectric developments, because in the cases of fuel or heat stations the province seems to be more clearly that of the "mechan-electric" engineer.

The sixth proposal, for special committee study, is not too clear, in so far as the subject matter of such study is concerned. Possibly the suggested scope is too broad for the work of a single committee. In any case, however, I believe that the broader economic aspects should be considered and that neither the Division nor the Society should shrink from the consideration of these aspects merely because they involve subjects of general public interest.

F. W. Scheidenhelm, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
April 19, 1937

Making Highways Safe

To the Editor: Much has been said and written concerning the design and construction of highways that will be safe for the automobile traffic of today and of the future. To both drivers and engineers, such matters as the number and width of lanes, amount of superelevation of curves, width of shoulders, depth of ditch, visibility, grade-crossing elimination, amount of crown, type of surface, curbs, guard rails, and landscaping seem to be all important.

All these factors must be considered, of course. Of more importance than any of them in the prevention of accidents, however, is double-tracking—that is, separate highways for traffic moving in opposite directions. The greatest hazard in traffic of any kind is the human equation. There would be many more train wrecks if instead of running on a track, the train were guided by the engineer, who had nothing but a white line to separate his train from another. When we consider that some automobiles can travel at locomotive speeds, meeting and passing each other with no more clearance than that used by the railroads, it is not hard to understand why we have accidents.

The complete separation of traffic should be demanded by the traveling public and should be incorporated in the plans for all new highways. Many super-highways having four or more lanes, with no separation except the "white line," have been built, even recently. As might be expected, the most modern highways are apt to have the most accidents. It is human nature to take all you can, and automobile drivers are no exception. Some drivers seem to think that the white line was meant as a guide for the wheels on the left side of their cars. When two such drivers meet, they illustrate the fact that two objects cannot occupy the same space at the same time. Then there is the driver who wants to take his half of the road right out of the middle.

This separation of traffic could be accomplished by several methods. Existing two-lane highways could be converted into one-way roads by constructing another two-lane road parallel, but not adjacent, to the original road. Three or four-lane roads could be separated by constructing a parking strip between the lanes carrying traffic in opposite directions. When changes in alignment are made the existing road could be left for one-way traffic, instead of being destroyed. This is being done, to some extent, in the South. As a feature of federal work relief, such a project would provide employment for the entire unemployed population of able-bodied men for a number of years.

Until a permanent separation can be made, the white line should be replaced by something wider and more emphatic. Projections of metal or concrete should be placed in such a manner that the wheels of a vehicle cannot be driven over them, parallel with the center line, without the driver's knowledge or without considerable discomfort to the passengers and some damage to the tires. The projections should be alternated, so that vehicles can safely cross them at an angle, on straight portions of the road and where visibility is good. On horizontal and vertical curves, where the visibility is poor, the projections should be continuous, so as to prevent passing. There probably always will be drivers who have no regard for their lives or the safety of others, but who rush headlong where angels fear to tread. The white line means just as much to them as a single strand of wire does to livestock. They can be kept in line by force.

George V. Long, M. Am. Soc. C.E.

Coshocton, Ohio
April 25, 1937

St. Lawrence Power Rates

To the Editor: In his article entitled "Are St. Lawrence Power Estimates Too High?" in the December 1936 issue, the late Theron M. Ripley, M. Am. Soc. C.E., quoted from my discussion of Dr. Mead's paper on the development of the international section of the St. Lawrence River (both in Transactions, Vol. 100). My statement regarding primary and secondary power was particularly referred to, and was used, with recent records of flow, to reach the conclusion that the installation proposed was not warranted and that, in consequence, the estimates of cost for the project should be revised.

I concur in the view expressed by the U. S. Lake Survey Office that present conditions on the Great Lakes represent a normal portion of a weather cycle, and that the projection of declining lake levels forty years into the future is not justified.

Moreover, I cannot agree with Mr. Ripley's conclusion regarding the question of the proposed installation in the St. Lawrence River plants. It is true that primary power is continuous power. But, with the exception of cases where power is supplied exclusively to basic industries, such as mining, smelting, paper making, and like manufactures, the load is never on a 100-per cent daily load-factor basis. Thus the output of a plant of primary power is not necessarily continuous 24-hour power. Systems of a size necessary to absorb the power from the St. Lawrence River plants will carry a diversified load in which domestic, commercial, and manufacturing loads will be represented, and will have a load factor less than unity. A system daily-load factor of 75 per cent would be comparatively high for such a case, so that if local storage were available, or the flow could be controlled to fit the load, primary power requirements could be met with a flow somewhat less than that required for a 24-hour load.

The Report of the Joint Board of Engineers presents a method of regulation for Lake Ontario, which would make available a flow of 185,000 cu ft per sec 100 per cent of the time, 1860 to 1925; 203,000 cu ft per sec, 90 per cent of the time; and 210,000 cu ft per sec, 73 per cent of the time. Utilizing the small range in stage which was considered feasible by the Joint Board of Engineers on the ponds above the proposed plants, and assuming a minimum flow of 185,000 cu ft per sec, a primary load corresponding to the assumed minimum flow of 210,000 cu ft per sec could be carried on the plants with a daily-load factor appreciably higher than the system daily-load factor previously mentioned. For flows in excess of the minimum it is evident that secondary power will be available.

It was assumed that Lake Ontario would provide only yearly storage, and, on account of the method proposed for controlling the outflow from the lake, a discharge of 210,000 cu ft per sec could be secured at elevations much lower than 244.70, as assumed in Mr. Ripley's paper. Examination of the regulation table for Lake Ontario, given in the Joint Board's Report, reveals that a flow of 221,000 cu ft per sec could be secured with a lake level of 244.07.

In view of all the facts, it is considered that the installation adopted for the different proposed plants is well justified.

Thomas H. Hogg, M. Am. Soc. C.E.
Chief Hydraulic Engineer, Hydroelectric Power Commission of Ontario

York Mills, Ontario
April 19, 1937

Stream-Regulation Study a Function of the Federal Government

To the Editor: I was interested in the symposium on the "Activities of the National Water Resources Committee," in the March issue of Civil Engineering. First, I should like to make a few personal observations on the Great Lakes Basin, one of the fourteen districts mentioned by Mr. Wolman in that symposium.

In my contacts with the state planning boards in the nine states of that district, and with the various agencies and men who were concerned with the water resources of their states, I found that the following particular interests were involved: (1) Sewage treatment and the elimination of stream pollution; (2) stream regulation, including flood remedial measures; and (3) navigation of the Great Lakes.

I have listed these interests in the order of importance that the states themselves seem to attach to them. In my opinion, it is not the order of real economic priority to the nation. The real order comes in reverse: (1) Navigation on the Great Lakes, including the St. Lawrence Waterway project and very incidentally its power feature in that connection; (2) stream regulation; and (3) stream pollution.

I believe the states are fully competent without any federal advice, interference, or assistance, to handle their own problems of stream pollution and control. If anything, I would criticize the activities of some of these agencies as being retroactive and defeating their own purpose, because in their enthusiasm they do not evaluate the economic factor in stream pollution. I must qualify the statement with respect to federal assistance on the stream-pollution question; and I wish to specifically commend the excellent work being done by the U. S. Public Health Service. It suffices all present needs.

The short time available for preparing the Drainage Basin Report, referred to by Mr. Wolman, precluded taking up the matter of stream regulation, including flood control. It was a disappointment to the state authorities, and the subject of some criticism, for they wish to correlate their flood control studies to the interstate drainage basins.

It seems to me that the next major duty of the National Water Resources Committee is the economic fundamentals of stream regulation. Such a study is essentially and logically a function of the federal government. Relief from floods and extreme low water, or the forecasting of flood stages, involves meteorologic data from vast areas even though the problem is applied to a particular state or municipality. The hydrologic study must cover the drainage basin, regardless of state boundaries.

In such work I am not suggesting that the Water Resources Committee get up specific plans on specific streams for certain purposes. I am talking about specific examples of the effect of fundamentals upon a particular basin. Let us consider, say, the Susquehanna Basin. When and how often may floods be expected there? How high will these floods rise at various points? What methods of hydrologic research have been developed to determine these things? What is the best procedure for going about it?

It seems to me that the vast expenditures proposed for flood remedial work and for stream control and regulation warrant fully this further study by the National Water Resources Committee.

L. K. Sherman, M. Am. Soc. C.E.
Consulting Engineer

Chicago, Ill.
April 29, 1937

SOCIETY AFFAIRS

Official and Semi-Official

San Antonio Entertains

Large and Successful Spring Meeting, April 21–24, Shows Results of Careful Planning

Smiling skies at San Antonio greeted Fiesta Week and with it the 1937 Spring Meeting of the Society. This was the season so well chosen by the local members for this all-important gathering and their judgment was fully vindicated in the splendid meeting that resulted. By the time the full measure of interest was recorded, the attendance figure reached more than 600. The success of the meeting was on the same generous scale.

In reality it began on Tuesday afternoon, April 20, when a group of representatives from the southern meeting region met in their annual Local Sections Conference to discuss desirable details for the Spring Meeting next year, to consider the proposal to assign all members of the Society to some Local Section, and to take up similar topics of interest to all the Sections. This meeting adjourned in time for the delegates to join other visitors at a party staged by the Texas Section in the Plaza Hotel.

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A Wild West Party

Somehow these members, with the traditional ingenuity of college students on a prank, had contrived to transport in sections and to reassemble on the roof garden, an old cook's vehicle used on cattle drives and borrowed from the collection of the late Will Rogers. This "chuck wagon" was the center of a plentiful and elaborate buffet supper. Meanwhile costumes of wide sombreros and red bandanas supplied for the occasion had made the visitors feel at home among the real cowboy costumes donned for the occasion by the local group. A hilarious spirit of cameraderie was the inevitable result. Campfire decorations, string music, an enlightening talk by J. Frank Dobie on Texas history, and several groups of cowboy songs provided the entertainment to round off the hearty meal.

About 10:30 p.m. the entire group repaired to a nearby theater where they were edified by a thrilling melodrama, *Murder in the Old Red Barn,* with all the realism the title implies. There they hissed the villain to their heart's desire and waited to see virtue amply vindicated and villainy punished in the end.

The State and Its Resources

With this as a flying start, the Spring Meeting officially opened on Wednesday morning with general sessions. First a representative of the Governor, followed by the Mayor of San Antonio, bade the Society hearty welcome. The President made fitting reply. The remainder of the morning session and all of the afternoon were devoted to an interesting exposition of there sources of Texas, including the natural prospects as well as those features developed by agriculture, transportation, and industry. This series of papers afforded ample justification for the intense pride of all Texans in their wonderful state.

Between these sessions the Texas Section had arranged a special treat in the form of a Mexican lunch. To many this was the first introduction to tamales, tortillas, and other delights of Mexican cooking. Brief introductions followed this interesting repast, and then the diners had to hasten back for the afternoon session.

Besides the technical meeting, a Student Conference was on the program. Both the Texas Agricultural and Mechanical College and the University of Texas had large delegations. But other colleges from further away were also much in evidence. Oklahoma, New Mexico, and Louisiana sent representatives, and some Chapters even as far off as Kansas, North Carolina, and Illinois answered the roll call. The students themselves conducted the meeting. After listening to interesting reminiscences from the President, and a stirring address by Director E. R. Needles, they turned to matters of common interest to the Chapters and the Society. Free and helpful discussions thus occupied the entire afternoon.

Division Meetings Prove Popular

Capacity crowds attended the Division meetings both morning and afternoon on Thursday, April 22, attesting to the excellence of the programs prepared for the several groups. The Highway Division, meeting in morning session, listened to reviews of highway planning and work in both Texas and Mexico, which were greatly enjoyed. The Irrigation Division held two full sessions, both morning and afternoon. Profitable discussions were enjoyed, covering the amount and development of water supply as well as its application to various irrigation projects in Texas. Likewise the Surveying and Mapping Division held morning and afternoon sessions, covering various surveying activities and principles as applied to conditions in Texas, as well as to the international boundary work between the United States and Mexico.

Interest also ran high in the joint meeting of the Construction and Structural Divisions in the afternoon. Illustrated talks on the Galveston Causeway and the San Jacinto memorial were followed by an instructive motion picture showing the technique of soils testing. An added feature was another motion picture covering the work of the Metropolitan Water District of Southern California. In spite of the length of this program, the large audience remained until the end.

Technical reports of these various papers will appear in the July issue.

Excursions and Sightseeing

While these technical sessions were monopolizing the interest of the men, the ladies were enjoying a variety of entertainment prepared for them. Sight-seeing rides, teas, and visits to historic sites were especially popular. In some of these, as on Friday, the men could also join. That entire day was given over to excursions. About 90 members and their families traveled 100 miles north of San Antonio, through the hill country to see the large multiple-arch Buchanan Dam on the Colorado River, rapidly nearing completion. They also visited Inches Dam, a gravity overflow structure for power development, about 5 miles below the larger structure.

Those who remained in San Antonio for the day were treated to a never-to-be-forgotten sight, the conclusion of "Fiesta Week." The spring of 1836 was memorable in the history of Texas and the United States. It was then that relations with Mexico came to a head, climaxed by the siege of the Alamo in February and the decisive battle of San Jacinto in April. Each year at this season San Antonio remembers its history with a Fiesta Week, and this year Society visitors enjoyed it to the full.

Society Participates in Fiesta

They even took part in the celebration, starting with the first event on Monday evening. Almost at the head of a long procession

Candid Camera Shots at the "Wild West Show" and the "Mexican Village"

San Antonio Meeting

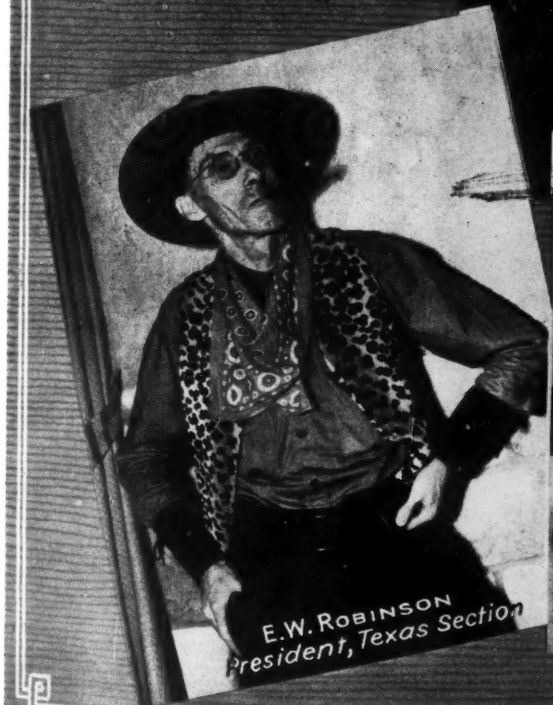
PRESIDENT HILL

DIRECTOR ARNESON
San Antonio, Texas

DIRECTOR & MRS. J. L. FEREBEE
Milwaukee, Wisc.

DIRECTOR NEEDLES
New York, N.Y.

PAST PRESIDENT TUTTLE



E. W. ROBINSON
President, Texas Section

MR. & MRS. W. H. LILLY
San Antonio, Texas

SECRETARY SEABURY

were representatives of the Society, including the President and prominent officers, bearing a large wreath in the shape of the Society badge. This with a hundred others was solemnly deposited at a special memorial ceremony in front of the historic Alamo, while bands played, and thousands stood reverently at the sound of "taps."

Other parades, of daily occurrence, punctuated the week. Then on Thursday evening in the capacious municipal auditorium, coronation ceremonies were conducted for the Queen of the carnival and her brilliant retinue of princesses. Climaxing the entire Fiesta Week, came the Battle of Flowers on Friday afternoon. Elaborate floats with historic and artistic motifs, dozens of bands, marchers galore, and hundreds of flower-decked autos made this two-hour parade memorable as a most beautiful and distinctive highlight of the Spring Meeting.

A MEXICAN VILLAGE ATMOSPHERE

Other social events also left their own pleasing memories. One of the most popular was the dinner dance in the ballroom of the Plaza Hotel, on Wednesday evening. Here also the artistic side was in evidence. Outside in the reception room a Mexican hut had been erected, and within it, the nationally famous tortillas were being prepared and baked. In the straw about the doorway were milk goats and their kids, a burro attended by two pretty senoritas; and alongside, a native with his foot-power pottery wheel, forming graceful bowls and cups and vases. Mexican dances and music enlivened the dinner. Then the entire floor was cleared for the greater enjoyment of the large number of dancers.

Less formal and correspondingly more spontaneous was the "Stag Barbecue" on Thursday evening. Held at an entertainment resort ten miles or so north of the city, this was widely attended. The local members staged an appetizing outdoor meal followed by entertainment, giving added evidence of the friendliness and hospitality that characterized the entire meeting.

HISTORIC GLORIES OF SAN ANTONIO

Although the anticipated excursion to Monterrey, Mexico, did not secure the needed quota to warrant undertaking it, the historic shrines and interesting scenes of San Antonio itself were widely enjoyed. Visits to the several flying fields nearby, to Fort Sam Houston, largest in the country, and to beautiful Brackenridge Park, were popular. Within a few blocks was the famous Alamo, now a public museum, and there many a visitor paid silent tribute to Travis, Bowie, Crocket, Bonham, and their historic band.

The Spanish missions also came in for a large and well-deserved share of attention. Engineers, of all people, find in them worthy objects of admiration for their artistic and engineering features, which seem admirable even on the basis of modern standards. Then there was the centrally located Governor's Palace, with its beautiful patio and interior furnishings, bearing eloquent witness to the dignity and comfort of the old Spanish home life.

Instances could be multiplied in elaborating the wonders of the city, the beauties of its surroundings, and the pleasures arranged in such abundance for all visitors. The San Antonio gathering was not just an ordinary conference of technical men; it was a Spring Meeting *par excellence*. Every credit belongs to the local officers and their efficient subcommittees for staging a program that will go down in Society annals as one of the best in a long line of successful meetings.

Meeting of Board of Direction—Secretary's Abstract

April 19 and 20, 1937

ON APRIL 19 and 20, 1937, the Board of Direction met at the Plaza Hotel in San Antonio, Tex., with President Louis C. Hill in the chair. In addition, Secretary Seabury and the following members of the Board were present: Past-Presidents Tuttle and Mead; Vice-Presidents Lupfer and Bellinger; and Directors Arneson, Burdick, Crawford, Davis, Dean, Ferebee, Finch, Hidinger, Hill, Legaré, Leisen, Morse, Myers, Needles, Poole, Proctor, Shea, Stabler, and Stanton.

Items from Executive Committee

A number of administrative matters which had previously received the study of the Executive Committee were adopted as the action of the Board or were acted upon separately as recommended. Some of these matters are incorporated in the minutes of the Board without specific reference to the action of the Executive Committee.

Minutes of January 17–19 Meeting Approved

The minutes of the outgoing Board meeting, January 17–19, 1937, were approved.

Revision of Minutes, January 21 Meeting

The Board voted to amend the minutes of its meeting of January 21, 1937, by including Director J. L. Ferebee as a member of the Committee on Registration of Engineers with term ending in January 1938. The Board expressed its regret that, in designating the personnel of the various committees for the year 1937, it inadvertently omitted his name as a member of that committee.

Otherwise, the minutes of the meeting were approved.

Allocation of Members to Local Sections

The report of the 1936 Committee on Local Sections, dealing with allocation of all members to Local Sections, was referred to a subcommittee of the Committee on Professional Activities, consisting of Directors Morse, Ferebee, Finch, Hidinger, Stabler, and Stanton, for study and report to a future meeting of the Board.

Amendment to By-Laws—Committee on Public Education

Under regular procedure Article IV, Section 10, of the By-Laws of the Society were amended in the following particulars: (1) The term, "Committee on Public Education" throughout the Section was amended to read, "Committee on Public Information"; (2) in paragraph (*b*) the last sentence was changed by the omission of the word "educational" so that it shall read: "Such work shall be carried on at all times in a manner consistent with the dignity of the Society."

Statistics in the Construction Industry

The Board endorsed a proposal for the collection of statistics of the construction industry by the government, including the appropriation of the necessary funds.

Proposed Symposium—"Diagramming or Tabulating Valuable Engineering Knowledge"

Proposal from J. A. L. Waddell, Hon. M. Am. Soc. C.E., originating at the Society's annual Meeting in January 1937, and suggesting that the Society arrange for an extensive symposium on "The Diagramming or Tabulating of Valuable Engineering Knowledge" was discussed. The Board concluded that under present circumstances it was not practicable for it to accept such responsibility.

Committee on Salaries

Detailed report was received from the Committee on Salaries, proposing equitable compensation in normal times for civil engineering positions defined by the federal classifications. The Board took this under advisement for further study before definite action.

Registration of Engineers

Report from the Committee on Registration of Engineers detailed the progress of two conferences held with representatives of 18 other engineering societies in a study of possibly desirable revisions of the "Model Law."

Norwich University Student Chapter

Reestablishment of a Student Chapter at Norwich University, Northfield, Vt., was approved, on a probationary basis for two years.

Committee Reports

Recommendations of several Board and Society committees received the consideration of the Board. Progress reports from other committees were received and discussed.

Future Meetings

Although the summer Convention for 1937 is to be held in Detroit instead of the Far West, the Board decided to include in that meeting a Local Sections Conference as heretofore. It was also voted that the 1938 Convention be held in the western area, in accordance with previous custom.

President Potter of American Engineering Council

On invitation, Dean Andrey A. Potter, President of American Engineering Council, addressed the Board briefly regarding the activities of Council.

Election of Officers

Under Constitutional procedure the Board unanimously elected the following to serve as its officers for the coming year:

Secretary, George T. Seabury
Treasurer, Otis E. Hovey
Assistant Treasurer, Ralph R. Rumery

Recognition for the Late Joseph M. Howe and Alfred D. Flinn

The Board unanimously adopted by standing vote the following resolutions for two of its former members:

Joseph Milton Howe

"The Board of Direction of the American Society of Civil Engineers, assembled this day for its Quarterly Meeting at San Antonio, Tex., has learned with deep regret of the passing of Joseph Milton Howe, a former Director of this Society from this District in which we are meeting, in 1924–1926, and Vice-President from this Zone in 1930–1931.

"Mr. Howe, a member of the Society since 1903, had taken an active part in the preparations for this meeting of the Society. In appreciation of his long and loyal service to the Society, the Board requests the Secretary to inscribe on its minutes, and to transmit to Mr. Howe's family, this expression of its deepest sympathy in the death of an outstanding member of the profession, and its sense of personal loss in the passing of a valued friend and colleague."

Alfred Douglas Flinn

"The Board of Direction of the American Society of Civil Engineers has learned with deep regret of the recent death of Alfred Douglas Flinn. Dr. Flinn, a member of this Society since 1899, and of its Board of Direction during the years 1917–1919, was always ready to contribute unselfishly of his time and ability to promote the interests of the American Society of Civil Engineers.

"From 1918 to the time of his death he served the Engineering Foundation, first as Secretary and later as Director. He was also Secretary of United Engineering Trustees from 1918 to 1924, when he retired in order to give his entire time to the work of Engineering Foundation. Dr. Flinn's whole career was characterized by wholehearted devotion to the best interests of the engineering profession.

"The Board desires to place on record its appreciation of Dr. Flinn's contributions to the upbuilding of the engineering profession, and to express its keen regret at his passing. The Board requests the Secretary to inscribe on the minutes of this meeting, and to transmit to the family of Dr. Flinn, this expression of the deepest sympathy of the members of the Board in the death of an outstanding member of the profession, and the sense of personal loss in the passing of a valued friend and colleague."

Resolution Re Hydrological Data

The Board adopted a resolution indicating its support of the government activity in collecting and publishing basic hydrological data, as noted in detail elsewhere in this issue.

Miscellaneous Matters

A number of other matters of routine or administrative nature were discussed and the necessary action taken.

Adjournment

The Board adjourned to meet in Detroit, Michigan on July 19, 1937.

June Instead of August "Proceedings"

This year Proceedings will be published in June, contrary to long-established routine. For many years, it has been the practice of the Society to omit publication of Proceedings through the two summer months of June and July. The purpose was to enable the limited staff to concentrate on the collation of papers for the annual volume of Transactions, and secondarily to solve the problem of personnel shortage during the vacation months.

After a very careful study, the Committee on Publications has decided to transfer the two recess months of Proceedings to July and August in order that all members who have become interested in the discussion of current papers may have ample opportunity to continue that interest a little later into the spring. Consequently this year there will be a June Proceedings, which will contain all the discussions written during May and accepted for publication. In the past much of this material has necessarily been deferred until the issue of August 15.

There has been rather definite indication that August 15, for so long the date of resuming publication, may be a little early to expect the members to "settle down" after summer activities to the serious study of technical papers. Consequently the new arrangement will bring Proceedings again to the desks of its readers on September 15, instead of August 15 as in former years. Correspondingly, it will extend by one month the period of active interest in this publication during the spring. The committee will look forward with interest to the effect in stimulating discussion activities which this change in plan is intended to encourage.

Connecticut Section Erects Memorial Tablet to Clemens Herschel

In connection with its Seventeenth Annual Meeting, held in New Haven on April 27, 1937, the Connecticut Section of the Society unveiled with appropriate ceremonies a tablet to the late Clemens Herschel, Past-President and Honorary Member of the Society, commemorating his achievement in designing the Ferry Street draw span over the Quinnipiac River.

QUINNIPIAC RIVER BRIDGE
OPENED TO TRAVEL 1875
DESIGNED BY
CLEMENS HERSCHEL
PRESIDENT AMERICAN SOCIETY OF CIVIL ENGINEERS
1916
THIS TABLET PLACED BY THE SOCIETY
1937

Tablet Memorializing Design of a New Haven Bridge by Clemens Herschel

Dedicated by the Connecticut Section on April 27, 1937

The unveiling took place in the presence of John W. Murphy, mayor of New Haven; Winslow Herschel, son of the designer; three other members of Mr. Herschel's family; and numerous officers and members of the Connecticut Section. At the dinner meeting an interesting talk about his father was given by Winslow Herschel, and other addresses were made by Clarence Blakeslee and R. A. Cairns, Members Am. Soc. C.E. The following remarks by C. J. Tilden, M. Am. Soc. C.E., chairman of the committee in charge of placing the tablet on the bridge, made at the unveiling, are of interest in view of the fact that Mr. Herschel's achievements in the field of hydraulics have overshadowed his structural work.

"Mr. Herschel was thirty-two when he began the design of this bridge. He had graduated from Harvard with highest honors at the age of eighteen, after which he studied his profession at Karlsruhe, returned to this country and opened an office in Boston as consulting engineer. He designed several bridges in Boston and vicinity, but the Quinnipiac draw span was the most important single structure for which he was responsible. His studies on this bridge led him to write, in 1874, an important, though brief, book entitled *Continuous Revolving Drawbridges*.

"In this work a number of subjects connected with the calculation of continuous girders were presented for the first time. It is a scholarly treatise with an impressive appendix listing many books and articles which the author had consulted. When it is remembered that Squire Whipple's work on *Bridge Building*, in which the analysis of framed structures was for the first time adequately and correctly presented, had appeared only 27 years before (1847), it is seen that Mr. Herschel was one of the earliest to tackle the problems of so-called higher structures.

"The field of structural engineering, however, did not offer a sufficient attraction to one of Mr. Herschel's originality and independence of thought. Bridge companies were standardizing bridge fabrication and erection to such an extent that there was little left for the independent construction engineer. This was one reason that led Herschel to abandon the structural field and turn his attention to hydraulics. To this field he devoted the remainder of a long and active life and in it won professional honors of the highest kind.

"This bridge, however, is a striking monument to his skill and mental vigor. Although over sixty years old, it is still an important part of the city's transportation service. The loads that it carries are doubtless far different from those contemplated by the designer. The science of modern bridge building has progressed so far that this structure looks hopelessly out of date. Nevertheless, it is still a fine old war-horse, putting in a full day of twenty-four hours, and a week of seven days, winter and summer, carrying New Haven's citizens on their errands of duty or pleasure. It is most fitting that the designer's name should be signed in bronze to this product of his brain and hand and that the old bridge should bear proudly this testimonial to the professional ability of the man who built it."

CIVIL ENGINEERING is indebted to Harold L. Blakeslee and Joseph P. Wadham, respectively president and secretary of the Connecticut Section, and to Professor Tilden, for the material and illustration used in this item. A more complete account of the meeting of the Section appears elsewhere in this issue.

More About the Annual Meeting of the Mid-South Section

HEADQUARTERS for the eighth annual meeting of the Mid-South Section, held on April 16 and 17, 1937, were at the Peabody Hotel, Memphis, Tenn., where the Chamber of Commerce furnished registration facilities. Mayor Watkins Overton of Memphis, in his welcoming address, paid tribute to the work that engineers are doing in assisting recovery from the depression. The Friday morning session was presided over by John H. Gardiner, of Fort Smith, Ark., president of the Mid-South Section, who introduced the speakers. Papers were given on regional planning in the Tennessee Valley and on the national water supply.

At noon the Section held a joint luncheon with the Memphis Engineers' Club. Here the engineers had the pleasure of hearing Laughlin McLean, executive secretary of the Mississippi Valley Association, in his forceful presentation of the Association's struggles to obtain the necessary legislation for the construction of flood-control works along the Mississippi. These works were instrumental in preventing more devastating flood damage than the record floods of 1937. There is much yet to be done he stated.

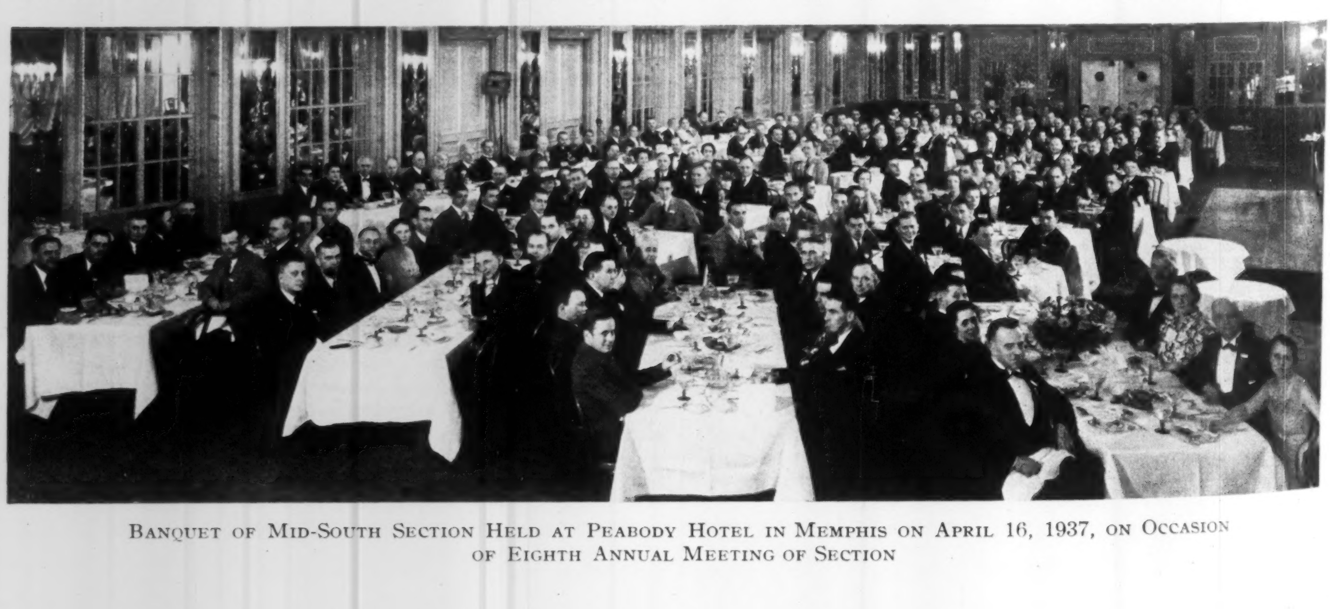
JOHN H. GARDINER, RETIRING PRESIDENT OF THE MID-SOUTH SECTION, J. J. RYAN, SECRETARY OF THE MEMPHIS ENGINEERS' CLUB, AND LOUIS C. HILL, PRESIDENT OF THE SOCIETY
At the Joint Luncheon of the Mid-South Section and the Memphis Engineers' Club on April 16, 1937

The luncheon was attended by a distinguished group of visiting engineers, including Louis C. Hill, President of the Society; Vice-President L. F. Bellinger; Director L. L. Hidinger; Secretary George T. Seabury; J. H. Porter, president of the St. Louis Section, and a delegation of 12 members of that Section; E. D. Burchard, president of the Tennessee Valley Section, with a delegation of 6; and C. G. Paulsen, president of the District of Columbia Section, with a delegation of 10. In the group were also two former Vice-Presidents (Col. F. G. Jonah, of St. Louis, and John C. Hoyt, of Washington) and two former Directors (W. W. Horner, of St. Louis, and E. B. Black, of the Kansas City Section). The Student Chapter at Mississippi State College was represented by Prof. Dewey McCain, faculty adviser, and 12 students; the Chapter at the University of Mississippi by Dean A. B. Hargis, faculty adviser, and 6 students. Other Founder Societies were represented by both Local Section and national officers.

The Friday afternoon meeting was presided over by N. B. Garver, of Little Rock, Ark. At this session there were technical talks on the economic aspects of engineering projects and the effect of the 1937 flood on the Mississippi River. Vice-President Bellinger also told of his visits to Local Sections in Zone II.

The banquet held at the Peabody Hotel on Friday evening was attended by nearly 200 members, ladies, and guests, and established a record for size and hilarity. Eugene F. Bespalow, Assoc. M. Am. Soc. C.E., was master of ceremonies in charge of the special entertainment features.

The Section concluded its two-day convention with a business session which included the election of officers for the ensuing year. A complete list of these officers as well as the names of the individual speakers at the technical sessions and the Friday evening banquet appeared in the May issue of CIVIL ENGINEERING.



BANQUET OF MID-SOUTH SECTION HELD AT PEABODY HOTEL IN MEMPHIS ON APRIL 16, 1937, ON OCCASION OF EIGHTH ANNUAL MEETING OF SECTION

Preparing for the Detroit Convention

Excellent Plans Nearing Completion for Society to Meet July 21–24, 1937

After a number of years the Society returns with pleasant memories to the city of Detroit, where it will hold its Convention the coming summer. The dates set are Wednesday, July 21, to Saturday, July 24. Extensive preparations have been under way for months and the plans are now matured to provide for every requirement of a successful summer gathering.

Some Promising Technical Sessions

As its theme the meeting will take the subject, "The Trend of Modern Transportation." Various programs will bring the different phases of this large subject to a focus, while other individual subjects will supplement this main topic, giving a good distribution of engineering interests.

View of Detroit Business Section

Headquarters will be located at the Statler Hotel. There, on Wednesday morning, July 21, the meeting will open with addresses of welcome by Mayor Frank Cousins, of Detroit, and by Leo J. Nowicki, Assoc. M. Am. Soc. C.E., Lieutenant-Governor of the State of Michigan. Then follows one of the traditional features of the Convention program, the annual presidential address, which Louis C. Hill will be privileged to deliver to his fellow members on one of the important occasions during his presidential year.

Opening the studies of modern transportation, Charles F. Kettering, president of General Motors Research Corporation, will then deliver the keynote speech. This will be followed up during the afternoon of the same day by valuable papers presented by Murray D. Van Wagoner, Michigan state highway commissioner, and by Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads.

Division Meeting in Morning Only

An innovation in the conduct of Society meetings has been introduced for Detroit. Departing somewhat from the usual practice, that is, the custom of devoting the entire second day of the Convention to meetings of the Technical Divisions, it has been planned to hold such Division programs only in the forenoon, both Thursday and Friday. This leaves the afternoons free for inspection of the many points of engineering interest in Detroit and vicinity. As far as practical, the Division sessions themselves will follow the transportation theme along the lines of their several specialties. For example, the Waterways Division will consider Great Lakes transportation, as well as the proposed compensatory works in the St. Clair River; the Highway Division expects to develop the themes of "The Place of the Express Highway in a Modern Road System" and "Trunk-Line Highways in Metropolitan Areas"; while the Sanitary Engineering Division will consider such topics as "Tourist Camp and Roadside Sanitation," "Seal of Safety Roadside Water Supply Program," and "Relationship Between the Extension Whole-Time Local Health Service and Highway Travel Safety."

Meanwhile the City Planning Division has in mind the topics, "The Need for Subsurface Utility Planning," and "Basic Principles in Subsurface Utility Planning"; while finally, the Structural Division has a subject important to Michigan traffic in "The Mackinac Straits Bridge Project and the Development of the Northern Peninsula."

Ample Time for Inspection Trips

With this daily program it becomes possible to devote Thursday and Friday afternoons, and all day Saturday if necessary, to a wide selection of inspection trips from which members may choose among those points of engineering interest which they particularly want to visit. No Convention in Detroit would be complete without provision for inspection of automobile plants. Then there are sewerage and incinerator developments, highway and street-widening projects, the Winsor Tunnel, Ambassador Bridge, Michigan Central Railroad Tunnel, Bell Isle Park, and a number of other attractive features.

Mindful of the fact that many will have in mind special places they wish to visit, the Local Committee is planning to accommodate all. This will diversify the stay and enable visitors to see the many attractions of this metropolis. Provisions for playing golf or enjoying other forms of entertainment have also been included. As it is impossible to visit all the many attractions during two afternoons, Saturday also will be left open to enable members to make the most of their stay in Detroit.

A Variety of Social Events

Supplementing the technical program and excursions to points of engineering interest, the Detroit members have not overlooked the social side of the Convention. On Wednesday evening, members, ladies, and guests will assemble in the grand ballroom of the Statler Hotel for dinner followed by entertainment. Thursday noon is reserved for a luncheon at which Arthur E. Morgan, M. Am. Soc. C.E., director of the Tennessee Valley Authority, will be the principal speaker. That same evening it is planned to hold a moonlight excursion on the river and lake.

Still another luncheon is planned for Friday, July 23. At that time the aims of the newly formed Engineering Society of Detroit will be explained. This local engineering organization, which has only been incorporated since April 1936, now has a membership approaching 3,000 and includes in its ranks all members of the profession. Affiliated with the society are local branches of the four Founder Societies, plus a dozen or so other important engineering organizations covering the entire field of technical activity.

An Ambitious Program

The aims of the Engineering Society of Detroit will be to aid the public to solve civic questions involving engineering problems, to encourage research in the investigation of engineering questions of public interest, and to provide in its headquarters library service, lectures, publications, and instructions on subjects tending to increase the technical skill and social usefulness of the members. The Society is to be supported by the income from the Rackham Engineering Foundation through an endowment created by the Horace H. Rackham and Mary A. Rackham Fund for the benefit of the engineering professions and allied arts and sciences in the Detroit area, and for the assistance of the public in meeting engineering problems.

It is some time since the Society has made it possible for members in the Middle West to attend a summer meeting in their own locality. For this reason it is expected that the Detroit Convention will be largely attended. Present plans for the program insure that a worth-while meeting will be provided for all those who can make the necessary arrangements to participate. Further details, including the complete program of the meeting, will be available in the July Civil Engineering. The present condensed announcement, however, gives sufficient information to enable members to make the decision to attend, confident of the value and pleasure to be derived from the meeting in store for them.

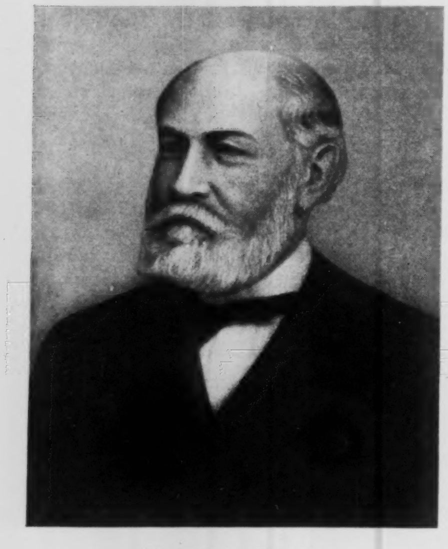
Early Presidents of the Society

XV. FREDERIC GRAFF, 1817–1890

President of the Society, 1885

Various members of the Society have been extremely helpful in supplying illustrative material and biographical data for this series of sketches. The help of still others is earnestly requested for future items. Photographs and personal anecdotes are especially valuable. The next three installments will treat of Henry Flad, William Ezra Worthen, and Thomas Coltrin Keefer.

AN EPIDEMIC of yellow fever in 1793 awakened the citizens of Philadelphia to the need for a supply of pure water. Benjamin H. Latrobe, one of the fathers of civil engineering in this country, was engaged to make investigations and plans, and by 1801 the Centre Square water works were in operation.



FREDERIC GRAFF
Fifteenth President of the Society

Frederic Graff, Sr., the father of the subject of this sketch, began his engineering career as a draftsman on this project in 1799, and became superintendent of the works six years later. With the growth of the system he acquired the title of chief engineer of the water department, and on his death in 1847 it passed to his son, who held it—with one interruption—until 1872. Thus for almost three-quarters of a century a Frederic Graff was in charge of the operation and development of the water supply of the city of Philadelphia.

It is somewhat curious that Frederic, Jr., entered the profession against the wishes and advice of his father. The elder man, feeling that his own life had been filled with much care and anxiety (accompanied by little in the way of pecuniary reward) resolved that his son should go into business. He placed him, therefore, with a large hardware concern, to learn the trade.

The young man did not take kindly to mercantile pursuits, and the owner of the firm, after giving him a fair trial, finally reported to his father that the youngster would never make a successful merchant, that his talent was, rather, along inventive and mechanical lines.

"Why," said the owner, "he spends all his leisure time making things of wood and strings; and the funny part is, everything he makes goes."

So the father yielded. Young Frederic studied engineering, and in 1842 he became assistant engineer of the water department.

The system that he "inherited" in 1847 was entirely the work of his father. It consisted mainly of the reservoir on Mount Morris (originally called Fairmount), a steam and water-power pumping plant on the bank of the Schuylkill River at the foot of the hill, and the attendant distributing mains. (The Centre Square works, on the site of the present City Hall, had been demolished 20 years before.)

By 1856 Frederic, Jr., had added the Corinthian Reservoir, installed the first turbine wheels at Fairmount Dam, and reorganized the whole department, combining the city works with those of the outlying districts of Spring Garden, Northern Liberties, and Kensington. He then resigned, but ten years later, on the urgent solicitation of his friends, he returned to the department for another six years of service. During this latter period as chief engineer he rebuilt the Fairmount Dam, built the Belmont Reservoir at George's Hill and a submerged main across the Schuylkill, and designed the large reservoirs in the East Park.

Graff's efforts to run his department on merit had kept him in more or less continuous warfare with his party, and the constant bickering and political by-play were repulsive to his nature. So in 1872 he declined a reelection. In 1883 he was again named for the position, but the scars of his earlier battles were still so fresh that he again refused to run. The remainder of his life was spent in private practice.

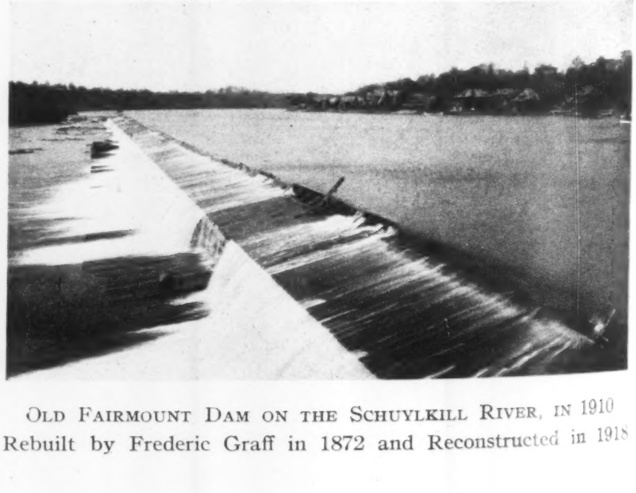
In private work, Graff's engagements included service as a member of various engineering boards, notably one appointed in 1886 to review the plans for the water supply of Washington, D.C. He also spent several years (1873–1877) with the late Henry R. Worthington, M. Am. Soc. C.E., in the development of water works and water works machinery. Mention may also be made of the unique pipe bridge across the Wissahickon, designed and built by him in 1863, in which the water pipe was used as a compression member.

In 1851, Graff, on his own initiative, laid the foundation for the great Fairmount Park System of Philadelphia, by placing before the city government his suggestion and plans for a park on the Schuylkill River. His active interest led directly to the purchase of the East Side park lands, and during their improvement he served energetically as a park commissioner, guiding the preparation and execution of the plans.

Graff was a quiet, unassuming man, but he gave largely of his time and means to the promotion of numerous charitable, educational, and cultural institutions in Philadelphia. He became a member of the Franklin Institute in 1839, served as a manager of that organization for five years, and as vice-president from 1882 until his death. For the Academy of Natural Sciences he served as trustee of the building fund. He became a director of the American Academy of Music in 1854 and continued in that position for 30 years. The Pennsylvania Museum and School of Industrial Art elected him as trustee in 1879, and later made him vice-president. He was one of the founders of the Zoological Society and Gardens, and became its president in 1882. In 1887 he was chosen as a director of the Pennsylvania Institute for the Deaf and Dumb.

"The significance of this list," said the writer of his memoir in the *Journal of the Franklin Institute* for June 1890, "lies chiefly in the fact that Mr. Graff never sought promotion, but, on the contrary, tried to avoid it. His prominence was always honorable, because it was always thrust upon him. His gentleness in manner and vigor in action, his integrity, experience, and clear judgment, were well known, and his associates always desired to have the benefit of them. When they had succeeded in persuading him to take the laboring oar, they were confident that the work would be well done, and they were not disappointed."

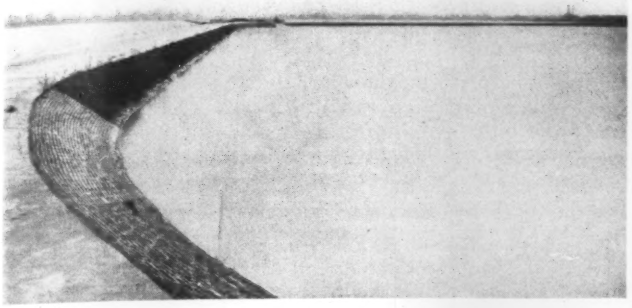
Graff took delight in the fine arts—architecture, music, painting, drawing, and carving. It has been said that his own skill in carving in wood and stone might alone have made him eminent. Though he practiced the art only as a hobby, some of his scarfpin heads, carved with a penknife from common marbles, rivaled



OLD FAIRMOUNT DAM ON THE SCHUYLKILL RIVER, IN 1910
Rebuilt by Frederic Graff in 1872 and Reconstructed in 1918

fine cameos in exquisiteness of workmanship. Another art in which he excelled as an amateur was photography, and in 1862 he helped to found the Photographic Society. Later he was its president for six years.

At the Centennial Exhibition in Philadelphia, in 1876, the American Society of Civil Engineers had charge of the presentation of American engineering. Graff was an active member of the Society's commission appointed for this work, and also directed the construction of the water supply for the exhibition grounds.



Division Wall of the East Park Reservoir, Philadelphia
Designed by Frederic Graff as Chief of the Water Department

For many years, Graff was aware that the condition of his heart made him liable to sudden death. Yet though this led him to avoid excitements, it did not disturb his cheerfulness or cause him to avoid the performance of duty. His geniality, it is said, made his companionship always a pleasure.

He died on March 30, 1890, survived by his wife. He left no children.

[Data for this sketch have been obtained from memoirs in the Proceedings of the Society and the *Journal of the Franklin Institute.* The water works photographs were furnished through the courtesy of Lyle L. Jenne, Assoc. M. Am. Soc. C.E.]

Collection of Hydrologic Data

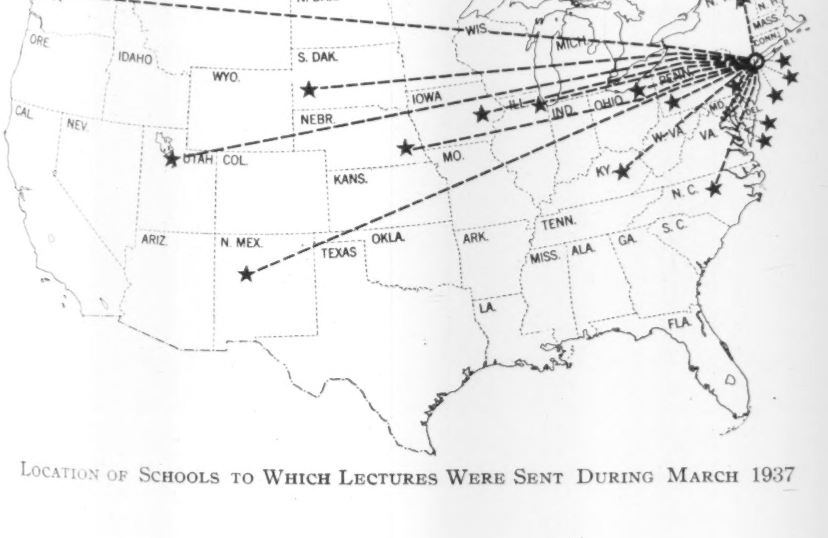
Engineers generally have been impressed with the need of gathering and making available a great deal of hydrologic information. This is considered to be needed as the basis for important flood and other studies which are now under way or impending. The Board of Direction at its San Antonio meeting recognized the value of such work and put its endorsement in the form of the following resolution, which it adopted:

> "Whereas, Basic hydrologic data are essential in the planning, design, and construction of all hydraulic-engineering projects, such as public water supplies, hydroelectric power plants, flood-control projects, irrigation undertakings, etc.; and
>
> "Whereas, Great losses of life and of money have resulted from both the under-design and the over-design of the structures involved, owing to the inadequacy of basic hydrologic data; and
>
> "Whereas, The report on "Deficiencies in Hydrologic Data," issued by the Water Resources Committee of the National Resources Committee, presents an orderly and reasonable continuing program for the collection and publication of basic hydrologic data by federal and state agencies cooperatively; and
>
> "Whereas, That report has been prepared by a competent group of experts in federal and private employment;
>
> "*Now, Therefore, Be It Resolved,* That the Board of Direction of the American Society of Civil Engineers endorses the plans for the collection and publication of basic hydrologic data in the aforesaid report; and the appropriation by Congress each year of the sums recommended in said report to the several federal agencies nominated therein, in addition to the sums regularly appropriated heretofore for the collection and publication of basic hydrologic data; and
>
> "*Be It Further Resolved,* That a copy of this resolution be transmitted to American Engineering Council, and that Council be urged to make this opinion of the Board available wherever practicable."

Lantern Lectures Prove Popular

Appended is a map drawn to illustrate the wide use of the lantern lectures which, for the past eight years, have been circulated among the Student Chapters of the Society. There are now available 18 different titles, as listed in Civil Engineering for September 1936. During the school year just completed, there have been 179 showings of these lectures. So great is the demand that each set of slides is made up in duplicate, and requests for reservations are not refused unless both sets are already engaged. During the month of March 1937, the lectures went out to 18 different schools and colleges, as shown on the map, the list being as follows:

Carnegie Institute of Technology
Case School of Applied Science
Catholic University of America
College of the City of New York
Cooper Union
Drexel Institute
Duke University
Lewis Institute
Manhattan College
South Dakota State School of Mines
State University of Iowa
University of Kentucky
University of Maryland
University of Nebraska
University of New Mexico
University of Utah
University of Vermont
University of Washington



Location of Schools to Which Lectures Were Sent During March 1937

Sixteen of the eighteen different titles were included in these showings. Some Chapters used more than one set, and some lectures were used three or four times during the month. The total number of showings was 29. The new material to be offered next year is already under way, and announcement regarding it will be made early in the autumn.

Regional Student Conferences Well Attended

Interesting Programs Presented at Spring Gatherings at Eastern Colleges

Since 1920, when the first Student Chapter was founded, there has been a marked increase of student interest in Society affairs. During the past seven or eight years this interest has been intensified by the occasional conferences of Chapter representatives, held at the time of the Spring and Fall Meetings of the Society, at which Chapter problems are discussed. A different type of student conference at which neighboring chapters get together year after year to conduct what is, in effect, almost a miniature Society meeting, was originated by the Philadelphia Section several years ago. The Society's Committee on Student Chapters is promoting the formation of more such conferences, and their success in this direction is attested by seven spring meetings, five of which are described here. Full credit for planning and conducting these interesting meetings should go to the student officers.

DURING THE PAST three months, there were seven Student Chapter conferences of representatives resident in definite regions. Accounts of five of these conferences follow; a write-up of the conference held at the University of Virginia appeared in the May number of CIVIL ENGINEERING; and an account of the University of North Carolina conference will be published, in a forthcoming issue, as soon as material on it is available. In addition to these regional conferences, a general Student Chapter Conference was held in connection with the San Antonio, Tex., meeting of the Society. The latter type of conference is scheduled whenever there is a suitable meeting of the Society as a whole; the former belongs in a geographical region where the Chapters at the various colleges take turns entertaining the other members of the group.

ALABAMA POLYTECHNIC INSTITUTE—APRIL 2–3

On April 2 and 3 the Alabama Polytechnic Institute Student Chapter was host to representatives from the Student Chapters at the University of Alabama, Tulane University, Georgia School of Technology, and Virginia Polytechnic Institute—a total of 59 students, together with eight members of the Alabama Section and L. F. Bellinger, Vice-President from Zone II. Part of the group attending this conference is shown in the accompanying photograph.

On the first day the meeting was called to order by M. E. Weatherby, president of the Alabama Polytechnic Institute Student Chapter. In an address of welcome John A. C. Callan, professor of civil engineering at Alabama Polytechnic Institute, stressed the need for unity in the engineering profession and the rôle of such conferences in achieving this end. After brief talks on the activities of the various Chapters during the year were given by the delegates, several other speakers were heard. These were A. C. Polk, consulting engineer and chairman of the Birmingham Industrial Water Works Project Commission, who described this project; Vice-President Bellinger, whose topic was "Job Getting and Job Keeping"; and Professor Elizondo, of the engineering department of the Institute, who discussed his engineering experiences in Mexico.

The afternoon's program consisted of motion pictures of the construction of Norris Dam, campus scenes, and a short comedy. Then J. E. Revelle, of the Chicago Bridge and Iron Works, presented a film showing the development of the work of the American Cast Iron Pipe Company. Later the Kappa Delta Sorority entertained the Student Chapter members with a tea dance, and the feature of the evening was an engineers' ball.

On April 3 much of the morning session was devoted to a business meeting. Then H. G. Faust, of Tulane University, presented an interesting paper on the water supply system of New Orleans. In the afternoon the group visited points of local interest, such as the textile mills and Martin Dam and the power plant. The convention was concluded with a banquet at the College Inn, with Professor Callan acting as toastmaster.

PART OF GROUP ATTENDING SOUTHEASTERN STUDENT CONFERENCE AT ALABAMA POLYTECHNIC INSTITUTE

JOHNS HOPKINS UNIVERSITY—APRIL 19

Approximately 150 delegates were present at the second annual conference of Student Chapters, in Maryland and the District of Columbia, which took place at Johns Hopkins University. The guest delegates represented the University of Maryland, George Washington University, and the Catholic University of America. Dr. Isaiah Bowman, president of the University, officially greeted the group at the morning session, during which Ernest Cloos, associate professor of geophysics at the University, spoke on "Geophysics as Applied to Engineering Problems." In his talk Dr. Cloos stressed the fact that the geophysicist can be of particular aid to the engineer in studying subsurface ground movement.

After a luncheon at the recently opened Faculty Club, the delegates visited the plant of the Bethlehem Steel Company at Sparrows Point, Md., the Chevrolet plant, and the new 29th Street Bridge, now under construction.

In the evening there was a dinner at the Faculty Club, with Thomas F. Hubbard, Faculty Adviser for the Johns Hopkins University Student Chapter, acting as toastmaster. An address of greeting was given by John B. Whitehead, dean of the school of engineering, and the Student Chapter officers and members of the various faculties represented made brief remarks.

The feature of the evening was an address by Abel Wolman, chief engineer of the Maryland State Department of Health. Recalling the recent floods in the Ohio and Mississippi valleys, Mr. Wolman pointed out the fact that the problems arising from such occurrences transcend all state boundaries and political parties. The showing of motion pictures of the Columbia Basin project concluded the conference.

VILLANOVA COLLEGE—APRIL 19

The Third Annual Student Convention of the Philadelphia Section of the Society was held at Villanova College on April 19, 1937, with a large representation from the various Student Chapters. The institutions cooperating in this convention are Bucknell University, Drexel Institute, the University of Delaware, Lafayette College, Lehigh Uinversity, Pennsylvania Military College, University of Pennsylvania, Pennsylvania State College, Swarthmore College, and Villanova College.

The following technical papers were presented: "The Relocation of the Guntersville River Road," by Lewis E. Hoffman, Drexel Institute; "A Progress Report on the Study of Reinforced Concrete Beams Subjected to Impact Loads," by H. Kent Preston, Jr., University of Delaware; "The Soil Consolidation Test and Its Relation to Foundation Design and Settlement of Buildings," by Thomas F. Spencer, Swarthmore College; "Stress Distribution in Welds Subjected to Bending," by Robert E. Crispen, Lehigh University; and "The Rise of the Skyscraper," by Albert S. Guerrina, Pennsylvania Military College.

The Board of Judges, in the student prize essay contest, awarded first prize to Thomas F. Spencer of Swarthmore College, second prize to Robert E. Crispen of Lehigh University, and third prize to Lewis E. Hoffman of Drexel Institute.

The beautiful day and the complete and careful arrangements made by the Villanova Chapter combined to make each person attending the convention feel that he had an especially happy time.

New York University—April 24

The Fourth Annual Spring Conference of the Metropolitan Conference of Student Chapters was held on the campus of New York University on Saturday, April 24, 1937. There were present about 100 members of the Chapters at Brooklyn Polytechnic Institute, College of the City of New York, Columbia University, Cooper Union, Manhattan College, Newark College of Engineering, New York University, and Rutgers University.

The conference was called to order at 10:50 a.m. by Sanford Koretsky, chairman of the Conference of Metropolitan Student Chapters. The morning session was then turned over to James R. Lightfoot, president of the evening division of the New York University Student Chapter. Dean Thorndike Saville, of the college of engineering at New York University, welcomed the group, and his talk was followed by a response by Melville Lyman, of the Newark College of Engineering. Robert Ridgway, Past-President and Honorary Member of the Society and Contact Member of the Chapter at Brooklyn Polytechnic Institute, spoke briefly.

There were then presented the first three papers by members of Chapters in the Metropolitan Conference, and the four remaining papers were given after luncheon. At the conclusion of the presentation of papers and while the committee was tabulating the ballots cast by the audience, a quartet from the sophomore class of the University sang, and motion pictures were shown. The afternoon session was under the chairmanship of John F. Curtin, of the New York University Student Chapter.

Prizes awarded by the Metropolitan Conference were presented by Arthur Hayden, Contact Member of the New York University Chapter, as follows: first prize, to Frank Schaffel, College of the City of New York, for his paper on "Analysis of Stress in Pedestals" and second prize, to Alexander Andreassen, Brooklyn Polytechnic Institute, for his paper on "An Introduction to Hydraulic Study with Models."

Opportunity was given for informal get-togethers before the morning session began, at the noon luncheon held at the Commons of New York University, and during an inspection of the engineering and aeronautical engineering buildings that followed adjournment.

The planning of the conference was in the hands of a subcommittee of the Metropolitan Conference of Student Chapters. Its execution was with the assistance of officers and committees of the New York University Chapter, to all of whom should be given credit for an interesting and enthusiastic spring conference.

Rensselaer Polytechnic Institute—May 7–8

The Student Chapter at Rensselaer Polytechnic Institute was host to Student Chapter representatives from eight institutions at a two-day session held on May 7–8, 1937. Nearly 100 students and faculty representatives were present from Clarkson College of Technology, College of the City of New York, Cornell University, Manhattan College, Newark College of Engineering, Rensselaer Polytechnic Institute, Syracuse University, and Union College.

On Friday evening there was advance registration and an opportunity to get acquainted. On Saturday morning the group was entertained at breakfast by the Rensselaer Student Chapter. Following this, a short business meeting was held, at which a committee was appointed to draw up a constitution for a permanent regional conference for northern New York.

At 10 o'clock the entire group adjourned to the plant of the W. and L. E. Gurley Company, manufacturers of engineering instruments, where in small groups they were conducted through the plant and given an opportunity to see how precise engineering instruments are made.

At noon the Rensselaer Student Chapter entertained the entire group at luncheon at the Troy Hotel, at which time President Hotchkiss, of Rensselaer Polytechnic Institute, formally welcomed the students and urged them to expand their professional training and contacts after their graduation. Professor Lawson, head of the department of civil engineering at the Institute, spoke, as did Mr. Enoch R. Needles, Director of the Society.

The conference then reassembled on the campus to listen to four student papers which had been announced as the winners of prize awards by the Rensselaer Student Chapter. A constitution for the permanent organization of the Northern New York Conference was brought in by the committee and adopted by the group. Its members will be the chapters at Clarkson, Cornell, Rensselaer, Union, and Syracuse.

At the conclusion of the meeting a rising vote of thanks was enthusiastically given for the generous hospitality of the Rensselaer Student Chapter and for the excellent planning and conduct of the meeting. R. K. Palmer, vice-president of the Rensselaer Chapter, was chairman of the committee that planned and carried out the conference. He was assisted in various ways by the presidents of other Chapters present and by other officers and committee members of the Rensselaer Chapter.

President Hill Attends Meeting at Conchas Dam

Members of the Society and other engineers engaged on the Conchas Dam project at Conchas Dam, N.Mex., met informally on April 26, 1937, to honor Louis C. Hill, President of the Society. Visiting the dam as a member of the Conchas Dam Consulting Board, President Hill gave an informal talk on some of his experiences in the design and construction of other high dams, particularly Roosevelt Dam. He stated that many methods which are common practice today in the design and construction of dams had not been developed, or were just in their infancy, after the turn of the century, when some of the first dams were being built in the West. At that time, he recalled, working conditions were far different from those prevailing at the present time. Transportation and communication were much more of a problem, and construction equipment was far from its present stage of development.

Other engineers, also members of the Conchas Dam Consulting Board, gave brief talks, paying tribute to President Hill's abilities and casting interesting sidelights on his career. Among them were Joel D. Justin, H. T. Cory, and Gerard H. Matthes, all Members of the Society. Thereafter, L. T. Grider, superintendent of construction of the main and wing dams of the Conchas Dam project for Bent Brothers, Inc., and Griffith Company, Los Angeles, Calif., referred to some of his earlier contacts with President Hill. The speakers were introduced by Hans Kramer, M. Am. Soc. C.E., Captain, Corps of Engineers, who is district engineer in charge of construction of the Conchas Dam project. Captain Kramer also furnished the material for the present item. The meeting was attended by approximately one hundred engineers who joined in general discussion with the speakers on points of mutual interest after the informal talks.

Manual on Filtering Materials Issued to the Membership

A manual on *Filtering Materials for Sewage Treatment Plants* has recently been issued to the membership. Compiled by the Committee of the Sanitary Engineering Division on Filtering Materials for Water and Sewage Works, this manual is the thirteenth published by the Society pursuant to the policy adopted by the Board of Direction in 1925. It outlines the general bases for determining the relative suitability of various materials as media for sewage filters and sets forth the more important items which should be covered by an engineer in specifying materials for a sewage filter, but does not attempt to provide a definite specification for filter materials. A more detailed account of its preparation, including the names of the committee personnel, appeared in Civil Engineering for January 1937.

Manual 13 was mailed to all members on May 13. Extra copies may be obtained from Society Headquarters at a cost of 30 cents to members and 60 cents to non-members.

Security of Employment in the Engineering Profession

This is the fourth in a series of articles covering the results of the Survey of the Engineering Profession made in 1935 by the Federal Bureau of Labor Statistics at the request of American Engineering Council. Previous articles were published in "Civil Engineering" for August 1936, and for February and May 1937. This article was prepared by Andrew Fraser, Jr., of the Bureau. There are reproduced herewith abstracts calculated to be of interest to civil engineers.

PRIOR to the onset of the depression in 1929, only non-professional workers were primarily concerned with the stability and security of employment. The effects of the depression years, however, were such as to bring about a quickening of interest in the subject of economic security even among professional workers. Because of this, a series of questions relating to this subject was incorporated into the Bureau's study of the engineering profession. Data were requested concerning the employment and separation contract, pension privileges, and the medium used to obtain a position, also whether or not the engineer reporting was under civil service.

The present article[1] is based upon data supplied by 35,559 engineers who reported the field of engineering engaged in and who had an engineering job in December 1934.[2] Their reports indicate that 68.4 per cent of all professional engineers used personal contacts and recommendations to obtain their jobs. Those who used this medium, together with those who obtained their positions through the civil service, formed nearly four-fifths of all those reporting.

The degree of economic security among professional engineers, as evidenced by possession of an employment contract covering some period of time, or by pension privileges, was negligible.

MEANS USED TO OBTAIN EMPLOYMENT

The data furnished by engineers concerning the medium through which they obtained employment are presented in Table I.

These figures demonstrate that for the engineering profession as a whole, placement was not the function of any particular organization. The vast majority of professional engineers obtained their jobs through personal contacts and recommendations. This was the means used to find the position held in 1934 by no less than 68.4 per cent of the 35,559 engineers who also reported the field of engineering activity in which they were engaged. This medium of employment was reported by three-quarters of the chemical, electrical, and mining and metallurgical engineers, and by slightly more than 70.0 per cent of the mechanical and industrial engineers, but by only 61.7 per cent of the civil engineers. The civil engineers, however, found more positions through civil service agencies; in fact, 2,941, or 80.0 per cent, of the 3,706 engineers who were classified under this medium were civil engineers. This is further emphasized by a consideration of the data for the five professional classes. Of the engineers who had engineering jobs in December 1934, 19.8 per cent of the civil engineers stated that these were found through the civil service, whereas among the remaining four professional classes, the range was from only 2.5 per cent for the chemical and ceramic to 4.6 per cent for the mining and metallurgical engineers.

It will, however, be noted that personal contacts and recommendations, together with civil service, accounted for 74.2 per cent of the mechanical and industrial engineers. For each of the remaining professional classes, these two mediums covered approximately four-fifths of their respective totals, ranging from 78.4 per cent of the chemical and ceramic to 81.5 per cent of the civil engineers. Mechanical and industrial engineers reported relatively higher percentages of jobs obtained through an engineering society, a private employment agency, and newspapers.

TABLE I. DISTRIBUTION OF ALL ENGINEERS REPORTING MEDIUM OF OBTAINING EMPLOYMENT, BY PROFESSIONAL CLASS, AT END OF 1934

Medium Used to Obtain Employment	Engineers Utilizing Each Specified Medium					
	All Professional Classes	Chemical and Ceramic Engineers	Civil, Agricultural, and Architectural Engineers	Electrical Engineers	Mechanical and Industrial Engineers	Mining and Metallurgical Engineers
			Number			
All mediums	35,559	2,538	14,861	6,816	9,833	1,511
Personal contacts and recommendations	24,312	1,927	9,179	5,106	6,960	1,140
Civil service	3,706	63	2,941	289	343	70
Engineering society	841	36	274	130	360	41
Private employment agency	576	49	113	112	285	17
Newspapers	567	27	152	120	255	13
Technical journals	363	54	142	64	85	18
United States Employment or Reemployment Service	264	7	190	14	46	7
Other public employment service	268	15	169	26	54	4
Any other medium	2,551	259	706	655	849	82
Medium not reported	2,111	101	995	300	596	119
			Per Cent			
All mediums	100.0	100.0	100.0	100.0	100.0	100.0
Personal contacts and recommendations	68.4	75.9	61.7	75.0	70.7	75.4
Civil service	10.4	2.5	19.8	4.2	3.5	4.6
Engineering society	2.4	1.4	1.8	1.9	3.7	2.7
Private employment agency	1.6	1.9	.8	1.6	2.9	1.1
Newspapers	1.6	1.1	1.0	1.8	2.6	.9
Technical journals	1.0	2.1	1.0	.9	.9	1.2
United States Employment or Reemployment Service	.7	.3	1.3	.2	.5	.5
Other public employment service	.8	.6	1.1	.4	.5	.3
Any other medium	7.2	10.2	4.8	9.6	8.6	5.4
Medium not reported	5.9	4.0	6.7	4.4	6.1	7.9

Although the percentage distributions for the remaining avenues to employment do not embrace large numbers of each professional class, relatively they do present some striking contrasts. Only 2.4 per cent of all engineers reported that they obtained their positions through an engineering society. Some 3.7 and 2.7 per cent, respectively, of the mechanical and industrial, and mining and metallurgical engineers were so classified. For the three remaining professional classes, the percentages ranged from 1.4 to 1.9. Despite the fact that so few engineers reported an engineering society as their employment medium, it must be recognized that such societies are an important factor in obtaining employment for professional engineers. It is obvious that through their members there must inevitably be a pooling of information on employment prospects, both locally and nationally. Furthermore, the officials of the various societies are kept in close touch with local and national employment conditions as a result of their meetings and conventions; but such appointments as are made would depend rather upon personal contacts and recommendations than upon contacts made through the society's employment service. The fact, therefore, that only 2.4 per cent of all engineers reported the

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[1] This is the fourth of a series of summary articles covering the results of the study. The previous articles were carried in the Monthly Labor Review for June 1936 and January and April 1937.

[2] The numbers reported in this article as engaged in engineering work in December 1934 cannot be compared with those shown in the discussion of employment. The former were derived from all of the 35,890 engineers who reported the field of engineering in which they were engaged. The discussion of employment dealt with all those older engineers who reported in the 3 years 1929, 1932, and 1934, and all 1930–32 engineers who reported in the years 1932 and 1934. The grand total, including the 1933–34 engineers, was 35,675.

Of the 35,890 engineers who gave income data in their special field, 331 did not report the year of their birth. Hence, 35,559 constitutes the base for all subsequent relationships with field of engineering engaged in. But 1,458 of these engineers did not report as to type of work engaged in, and hence 34,101 was used as a base figure for all subsequent relationships with functional classification.

TABLE II. DISTRIBUTION OF ALL ENGINEERS REPORTING AS TO CIVIL SERVICE STATUS, BY FIELD OF ACTIVITY AND PROFESSIONAL CLASS, AT END OF 1934

Field of Employment and Professional Class	Number				Per Cent			
	Total	Without Status	With Status	Not Reporting	Total	Without Status	With Status	Not Reporting
Federal government	4,649	2,084	2,250	315	100.0	44.8	48.4	6.8
Chemical and ceramic	74	22	44	8	100.0	29.7	59.5	10.8
Civil, agricultural, and architectural	3,620	1,649	1,734	237	100.0	45.6	47.9	6.5
Electrical	306	143	138	25	100.0	46.7	45.1	8.2
Mechanical and industrial	549	240	272	37	100.0	43.7	49.6	6.7
Mining and metallurgical	100	30	62	8	100.0	30.0	62.0	8.0
State and county governments	4,438	2,487	1,604	347	100.0	56.1	36.1	7.8
Chemical and ceramic	37	30	3	4	100.0	81.1	8.1	10.8
Civil, agricultural, and architectural	4,044	2,203	1,535	306	100.0	54.4	38.0	7.6
Electrical	134	91	33	10	100.0	67.9	24.6	7.5
Mechanical and industrial	170	123	28	19	100.0	72.3	16.5	11.2
Mining and metallurgical	53	40	5	8	100.0	75.5	9.4	15.1
Municipal governments	2,090	1,028	952	110	100.0	49.1	45.6	5.3
Chemical and ceramic	54	28	23	3	100.0	51.8	42.6	5.6
Civil, agricultural, and architectural	1,617	829	709	79	100.0	51.3	43.8	4.9
Electrical	238	88	136	14	100.0	37.0	57.1	5.9
Mechanical and industrial	158	70	77	11	100.0	44.3	48.7	7.0
Mining and metallurgical	23	13	7	3	100.0	56.6	30.4	13.0

engineering society as their medium of employment must be interpreted in the light of these conditions.

The securing of employment through newspapers and technical journals was reported by 1.6 and 1.0 per cent, respectively, of all engineers making returns. It will be noted, however, that, relatively, electrical and mechanical and industrial engineers found more jobs through newspapers than did any of the other professional classes; this medium was reported by 1.8 per cent of the electrical and 2.6 per cent of the mechanical and industrial engineers, whereas, among the other classes the highest percentage was 1.1. On the other hand, technical journals as a medium of employment were of more assistance to chemical and ceramic engineers (2.1 per cent); among the remaining professional classes percentages ranged from 0.9 to 1.2.

Private employment agencies were used by only 1.6 per cent of all engineers reported. When considered together, the two public employment agencies embraced approximately the same proportion, namely, 1.5 per cent. A similar comparison among the five professional classes showed that, relatively, public agencies were of more importance to civil engineers, of whom 2.4 per cent so reported, whereas the next highest percentage was 1.0 per cent for mechanical and industrial engineers. Only 0.8 per cent of the civil engineers used private employment agencies to obtain jobs, but 2.9 per cent of the mechanical and industrial engineers did so; for the remaining professional classes, the percentages ranged from 1.1 to 1.9 per cent.

ECONOMIC SECURITY IN THE ENGINEERING PROFESSION

A written contract of employment and pension privileges are two important criteria of economic security. The efficacy of any such schemes, however, depends to a marked extent upon the nature of the employment. This is demonstrated by a comparison of the data concerning economic security among professional engineers who reported as being engaged in public engineering, personal service, and private engineering.

Civil Service Status. The importance of civil service status as a factor in stability of employment is shown in Table II.

Despite the fact that, in all, 11,177 of the engineers reporting were in the employ of public authorities in December 1934, only 45.0 per cent of them reported as being under civil service. The proportion of all engineers with civil service status was 48.4 per cent in the case of positions under the federal government, and for employment with state and county, and municipal governments, 36.1 and 45.6 per cent, respectively. This percentage under civil service of these engineers employed by the federal government was higher than in the two other public employments, despite the enormous increase in federal government employment by December 1934, because of the amount of temporary employment under the work-relief programs; it may be assumed that relatively few of the engineers so employed would be classified under civil service. Consequently, under normal circumstances, the proportion of all engineers under civil service with the federal government would be higher than 48.4 per cent. On the other hand, with regard to the other two classes of public engineering, it will be recalled that the numbers of engineers so engaged remained comparatively stable over the period 1930–1934. Hence, the proportions reported as being under civil service are representative of the situation.

The relative proportions of each professional class under civil service differed very markedly among the three classes of public engineering employment. The smallest range occurred in federal positions—from 45.1 per cent for electrical engineers to 62.0 per cent for mining and metallurgical engineers. These two professional classes also constituted the extremes of the range of the proportions embraced by municipal governments, but in reverse order. Thus, of the mining and metallurgical engineers in municipal employment, 30.4 per cent, and of the electrical engineers, 57.1 per cent, had civil service status. Relatively, the smallest numbers of each professional class under civil service were found in state and county governments. This is best exemplified by the comparative data for civil engineers; of their number 47.9 and 43.8 per cent, respectively, in federal and municipal employments, but only 38.0 per cent in state and county positions had civil service status. But since the civil engineers comprised approximately 80.0 per cent of the 5,038 engineers who were under civil service, it is obvious that such a status is a significant contributory factor to the stability of employment.

The Employment Contract. For the engineering profession as a whole, the data in Table III clearly evidence a lack of economic security in terms of a written contract which would secure employment over a substantial period of time. In all, only 3,169, or 8.9 per cent, of the 35,559 engineers who reported employment in an engineering field[3] were covered by a written contract. Of these, some 0.8 per cent had a contract for less than one year, 3.5 per cent a contract for between one and two years, and only 0.9 per cent for two years or more. Engineers who did not report as to period of contract formed 3.7 per cent of the whole. No less than 91.1 per cent either answered "No" or did not furnish specific information.

Comparison of the positive returns on employment contract from all engineers in the three broad fields of engineering activity shows that use of the contract was most common in personal service—primarily education.

For engineers under contract in the personal-service field the most common contract period (reported by 25.6 per cent of the 2,778 engineers so engaged) was from one to two years. Some 4.0 per cent were under contract for periods of two years or longer. Although the corresponding percentages for public engineering were much lower than for personal service, they were higher than for private engineering. For employment contracts under one year, however, private exceeded public engineering (1.0 per cent, as against 0.5 per cent). Of all reporting engineers engaged in public engineering, 2.0 per cent had contracts for one and under two years, and 1.1 per cent for periods of two years and over. The corresponding percentages for private engineering were 1.4 and 0.5 per cent.

For the separate fields of activity under private engineering relatively the largest proportion of engineers under contract in their jobs occurred in manufacturing, with 408, or 3.8 per cent, of the 10,888 reporting as so engaged. In the construction and extractive industries 3.0 and 2.0 per cent, respectively, had written contracts. The smallest proportions under contract were reported by engineers in the employ of public utilities or engaged in transportation (1.1 and 0.9 per cent, respectively). In public engineering, there was a marked contrast in contract status between federal positions and those in the two other categories of public engineering. Thus, while only 2.3 per cent of the 4,649 reporting engineers in federal employ were on contract, the proportion working on this basis for state and county, and for municipal and other public author-

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[3] Throughout the whole of this discussion, only engineering employment is considered. Consequently, no cognizance has been taken of the economic security of engineers engaged in non-engineering employment.

TABLE III. DISTRIBUTION OF ALL ENGINEERS REPORTING EMPLOYMENT CONTRACT, BY FIELD OF EMPLOYMENT AT END OF 1934

Field of Employment	Number						Per Cent					
		Under Contract for:						Under Contract for:				
	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract No Period Reported	Not Reporting[1]	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract, No Period Reported	Not Reporting[1]
All fields	35,559	295	1,234	330	1,310	32,390	100.0	0.8	3.5	0.9	3.7	91.1
Private engineering	21,604	212	298	99	637	20,358	100.0	1.0	1.4	0.5	2.9	94.2
Construction	3,437	32	63	12	113	3,217	100.0	0.9	1.8	0.3	3.3	93.7
Extractive industries	1,841	11	21	6	60	1,743	100.0	0.6	1.1	0.3	3.3	94.7
Public utilities	4,183	16	21	8	50	4,088	100.0	0.4	0.5	0.2	1.2	97.7
Transportation	1,255	5	4	2	17	1,227	100.0	0.4	0.3	0.2	1.4	97.7
Manufacturing	10,888	148	189	71	397	10,083	100.0	1.4	1.7	0.7	3.6	92.6
Public engineering	11,177	53	224	121	295	10,484	100.0	0.5	2.0	1.1	2.6	93.8
Federal government	4,649	33	42	34	181	4,359	100.0	0.7	0.9	0.7	3.9	93.8
State and county government	4,438	15	125	50	81	4,167	100.0	0.3	2.8	1.1	1.8	94.0
Municipal and other public authorities	2,090	5	57	37	33	1,958	100.0	0.2	2.7	1.8	1.6	93.7
Personal service	2,778	30	712	110	378	1,548	100.0	1.1	25.6	4.0	13.6	55.7

[1] Also includes those who reported "No," which number could not be separated in the tabulation.

TABLE IV. DISTRIBUTION OF ALL ENGINEERS REPORTING EMPLOYMENT CONTRACT, BY TYPE OF WORK ENGAGED IN AT END OF 1934

Type of Work	Number						Per Cent					
		Under Contract for:						Under Contract for:				
	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract, No Period Reported	Not Reporting[1]	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract, No Period Reported	Not Reporting[1]
All types	34,101	288	1,196	311	1,236	31,070	100.0	0.8	3.5	0.9	3.6	91.2
Design and research	9,050	106	119	52	305	8,468	100.0	1.2	1.3	0.6	3.4	93.5
Construction	8,233	39	153	63	209	7,769	100.0	0.5	1.9	0.8	2.5	94.3
Operation	8,276	57	79	38	148	7,954	100.0	0.7	1.0	0.5	1.8	96.0
Consulting	2,146	26	30	11	80	1,999	100.0	1.2	1.4	0.5	3.7	93.2
Teaching	2,050	24	692	98	350	886	100.0	1.2	33.8	4.8	17.1	43.1
Sales	1,513	15	59	7	56	1,376	100.0	1.0	3.9	0.5	3.7	90.9
General administration and management	2,833	21	64	42	88	2,618	100.0	0.7	2.3	1.5	3.1	92.4

[1] Also includes those who reported "No," which number could not be separated in the tabulation.

TABLE V. DISTRIBUTION OF ALL ENGINEERS REPORTING SEPARATION CONTRACT, BY FIELD OF EMPLOYMENT AT END OF 1934

Field of Employment	Number						Per Cent					
		Under Contract for:						Under Contract for:				
	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract No Period Reported	Not Reporting[1]	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract, No Period Reported	Not Reporting[1]
All employments	35,559	287	77	128	95	34,972	100.0	0.8	0.2	0.4	0.3	98.3
Private engineering	21,604	180	67	124	38	21,195	100.0	0.8	0.3	0.6	0.2	98.1
Construction	3,437	32	5	8	10	3,382	100.0	0.9	0.1	0.2	0.3	98.5
Extractive industries	1,841	19	1	2	4	1,815	100.0	1.0	0.1	0.1	0.2	98.6
Public utilities	4,183	16	2	2	4	4,159	100.0	0.4	(2)	(2)	0.1	99.5
Transportation	1,255	2	..	...	2	1,251	100.0	0.2	...	...	0.2	99.6
Manufacturing	10,888	111	59	112	18	10,588	100.0	1.0	0.5	1.0	0.2	97.3
Public engineering	11,177	50	3	2	26	11,096	100.0	0.4	(2)	(2)	0.2	99.4
Federal government	4,649	16	1	2	8	4,622	100.0	0.3	(2)	(2)	0.2	99.5
State and county governments	4,438	27	1	...	10	4,400	100.0	0.6	(2)	...	0.2	99.2
Municipal governments	2,090	7	1	...	8	2,074	100.0	0.3	(2)	...	0.4	99.3
Personal service	2,778	57	7	2	31	2,681	100.0	2.1	0.3	0.1	1.1	96.4

[1] Also includes those who reported "No," which number could not be separated in the tabulation.
[2] Less than 1/10 of 1 per cent.

TABLE VI. DISTRIBUTION OF ALL ENGINEERS REPORTING SEPARATION CONTRACT, BY TYPE OF WORK ENGAGED IN AT END OF 1934

Type of Work	Number						Per Cent					
		Under Contract for:						Under Contract for:				
	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract, No Period Reported	Not Reporting[1]	Total	Under 1 Year	1 and Under 2 Years	2 Years and Over	Under Contract, No Period Reported	Not Reporting[1]
All types	34,101	274	72	122	93	33,540	100.0	0.8	0.2	0.4	0.3	98.3
Design and research	9,050	68	33	62	15	8,872	100.0	0.8	0.4	0.7	0.2	97.9
Construction	8,233	45	9	2	18	8,159	100.0	0.5	0.1	(2)	0.2	99.2
Operation	8,276	52	12	33	16	8,163	100.0	0.6	0.1	0.4	0.2	98.7
Consulting	2,146	10	..	9	8	2,119	100.0	0.5	...	0.4	0.4	98.7
Teaching	2,050	51	6	...	31	1,962	100.0	2.5	0.3	...	1.5	95.7
Sales	1,513	28	6	5	1	1,473	100.0	1.9	0.4	0.3	0.1	97.3
General administration and management	2,833	20	6	11	4	2,792	100.0	0.7	0.2	0.4	0.1	98.6

[1] Also includes those who reported "No," which number could not be separated in the tabulation.
[2] Less than 1/10 of 1 per cent.

Table VII. Distribution of All Engineers Reporting Pension Privileges, by Field of Employment at End of 1934

	Number					Per Cent				
			Pension Privilege					Pension Privilege		
Field of Employment	Total	No Pension	Contributory Plan	Non-Contributory Plan	Not Reporting	Total	No Pension	Contributory Plan	Non-Contributory Plan	Not Reporting
All employments	35,559	20,556	6,684	3,957	4,362	100.0	57.8	18.8	11.1	12.3
Private engineering	21,604	13,207	2,265	3,387	2,745	100.0	61.1	10.5	15.7	12.7
Construction	3,437	2,445	174	138	680	100.0	71.1	5.1	4.0	19.8
Extractive industries	1,841	1,109	272	200	260	100.0	60.2	14.8	10.9	14.1
Public utilities	4,183	1,833	341	1,555	454	100.0	43.7	8.2	37.2	10.9
Transportation	1,255	576	120	416	143	100.0	45.9	9.6	33.1	11.4
Manufacturing	10,888	7,244	1,358	1,078	1,208	100.0	66.5	12.5	9.9	11.1
Public engineering	11,177	5,791	3,827	357	1,202	100.0	51.8	34.2	3.2	10.8
Federal government	4,649	1,850	2,009	248	542	100.0	39.8	43.2	5.3	11.7
State and county governments	4,438	2,723	1,193	58	464	100.0	61.3	26.9	1.3	10.5
Municipal governments	2,090	1,218	625	51	196	100.0	58.3	29.9	2.4	9.4
Personal service	2,778	1,558	592	213	415	100.0	56.1	21.3	7.7	14.9

ities formed respectively 4.2 and 4.7 per cent of their grand totals.

The type of work in which engineers under contract were engaged is presented in Table IV.

Table IV also confirms the previous finding that engineers engaged in teaching are relatively more secure with regard to employment than other members of the engineering profession: 33.8 per cent of their number reported written contracts for periods of from one to two years. Sales employments, next in order, had under contract for a similar period only 3.9 per cent of their 1,513 reporting engineers, and general administration and management only 2.3 per cent. Each of the other functional classes had less than 2.0 per cent. Even for the contract periods of two years and over, teaching covered 4.8 per cent of the total reported for this functional class. The next highest percentage, namely, 1.5, was reported for general administration and management. In no one of the remaining employments did the percentage of engineers with written contracts for two years and over exceed 0.8 per cent.

Thus, with regard to fields of activity or the functional classes within them, the engineering profession cannot be said to have any substantial security of employment provided through a written contract for a period of time. On the other hand, professional engineers are not generally restricted with regard to the seeking of employment similar to that in which they may be engaged. This is evidenced by a consideration of the data furnished by professional engineers concerning their separation-contract status (Tables V and VI).

Only 1.4 per cent of all the reporting engineers stated that they were under a contract for a definite period of time during which they bound themselves not to seek similar employment. This included 0.8 per cent whose separation contracts were for less than one year, 0.2 per cent for a period of from one to two years, and 0.4 per cent for two years and over. Clearly, restrictions upon professional engineers with regard to new employment were few.

Provision for Retirement on Pension. An analysis of the data furnished by professional engineers concerning their pension privileges is presented in Table VII.

As of December 1934 almost one-third (10,641) of the 35,559 professional engineers reporting who had engineering jobs at that time stated that they had pension privileges. Of this number, 6,684, or 18.8 per cent, were covered by contributory pension schemes, and 3,957, or 11.1 per cent, by non-contributory schemes. Some 57.8 per cent were in employments for which no pension provision had been made. About 12.3 per cent did not furnish information.

Of the engineers in pensionable positions, the smallest relative proportion, 26.2 per cent, were engaged in private engineering. By contrast, 37.4 per cent of the engineers engaged in public engineering and 29.0 per cent of those in personal service had pension privileges. It will also be noted that for public engineering and personal service the contributory scheme predominated.

On the other hand, of the engineers engaged in private engineering, the largest proportion was covered by non-contributory systems. However, within the private-engineering group marked differences were shown; the same was true of the three categories of public engineering.

The largest number of professional engineers covered by a pension plan were those in the employ of the federal government. Out of a total employment of 4,649 engineers reporting, 43.2 per cent were under a contributory and only 5.3 per cent under a non-contributory plan. The corresponding proportions in positions with state and county, and municipal governments were very much less—26.9 and 1.3 per cent, respectively. For municipal-government employment the figures were 29.9 and 2.4 per cent. This order of difference parallels that of the proportions of engineers under civil service in these three classes of employment, but only in the case of the federal government are the two proportions closely related. This arises from the fact that, whereas all persons under federal civil service must contribute to the retirement fund, this is not true to the same extent for employments under state and county, and municipal and other public authorities, where age, length of service, and salary are also taken into consideration.

Among the remaining fields of activity, public utilities and transportation reported the next highest proportions (after federal employment) as having pension privileges. Public utilities and transportation used the non-contributory scheme; this type of plan covered 37.2 per cent in utilities and 33.1 per cent in transportation; contributory systems covered only 8.2 and 9.6 per cent, respectively, of those reporting. For the three remaining pursuits shown under private engineering, the largest number of engineers with pension privileges did not exceed 25.7 per cent, and in all cases contributory schemes predominated.

From the preceding discussion of the pension privileges it is quite evident that the kind of employment has a marked effect upon the question of the installation of a pension scheme. In no type of engineering employment was a majority of the reporting engineers protected by such a plan.

Local Unit of Tennessee Valley Section Formed

Thirteen members of the Tennessee Valley Section of the Society met at the George Vanderbilt Hotel in Asheville, N.C., on April 19, 1937, and completed the organization of a local unit to represent the Asheville District of the Section. Preliminary organization plans were made at a previous meeting held on March 29, 1937.

Officers elected were as follows: President, R. L. Maynard, city engineer of Asheville and vice-president of the Tennessee Valley Section in charge of the Asheville District; vice-president, Joe Dave, president of the Dave Steel Company; secretary and treasurer, M. O. Jensen, junior hydraulic engineer with the T.V.A. The president of the Tennessee Valley Section, E. D. Burchard, is himself a member of the Asheville unit and served as its temporary chairman while it was in the process of being organized.

Plans call for dinner meetings on the third Monday of each month, to which members are free to invite guests. The group hopes to secure prominent engineers as guest speakers at frequent meetings, which members of other engineering societies will be invited to attend. Members of the American Society of Civil Engineers in and around Asheville are showing much interest in the new organization.

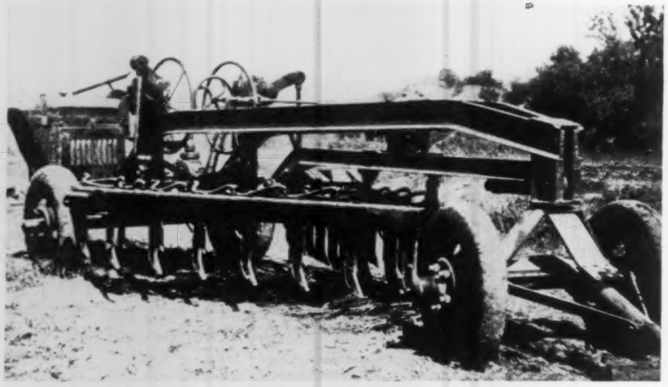
Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

For the first time, "Proceedings" will be published in June, to accommodate the discussions of papers appearing during the spring months. Every effort will be made to include discussions up to the latest possible moment. Three papers—on stabilizing the material in low-cost earth roads, pile foundations, and reinforced concrete pavements, respectively—will supply study material for the summer months, allowing ample time for preparing discussions for the next "Proceedings" (*to be issued to members on September 15*).

ESSENTIAL CONSIDERATIONS IN THE STABILIZATION OF SOIL

At the 1935 Fall Meeting of the Society, in Birmingham, Ala., the program of the Highway Division increased interest in the problem of stabilizing the materials used in the construction of soil roads. One of the papers on that program was written by C. A. Hogentogler, Assoc. M. Am. Soc. C.E., and E. A. Willis, of the U. S. Bureau of Public Roads. A brief abstract of this paper was published in the December 1935 issue of CIVIL ENGINEERING. A paper entitled "Essential Considerations in the Stabilization of Soil " by the same authors is now scheduled for publication in the June issue of PROCEEDINGS. Based on the earlier paper, the present paper on this subject has been considerably expanded. It contains quite a complete report of observations and has been made strictly up to date.



"SUB OILER" FOR APPLYING BITUMINOUS MATERIAL IN SOIL STABILIZATION

The treatment of ordinary dirt roads so as to give them enough abrasive resistance and sheer strength to accommodate modern traffic under all weather conditions, is treated thoroughly in this paper, which leads logically to the conclusion that the use of water-retentive chemicals has been found a valuable supplement in the construction and stabilization of properly graded road mixture. Water-insoluble binders, including bituminous material and portland cement, are also recommended for stabilizing poorly graded and fine graded soils. Ten itemized conclusions are listed for discussion, and an adequate bibliography forms an appendix to the paper. An example of the modern equipment now used for applying bituminous material is shown in the accompanying photograph.

EFFECT OF DOWEL BAR MISALIGNMENT ACROSS CONCRETE PAVEMENT JOINTS

A research problem of more than passing interest and value is described in a paper entitled "Effect of Dowel Bar Misalignment Across Concrete Pavement Joints," by Arthur R. Smith, M. Am. Soc. C.E., and Sanford W. Benham, Assoc. M. Am. Soc. C.E. Superficially, the problem of transferring wheel load across a joint in a highway pavement seems to be a relatively simple detail of design. Nevertheless, to avoid retarding the action for which joints are created, the dowel bars must be placed perpendicular to the pavement cross section (parallel to the line of movement of the pavement) so as to avoid tying adjacent slabs together. If the dowels are placed carelessly during construction, the skew with which they pass through the joint will cause them to bind in the concrete as the joint opens and closes, the effect of which will be damage to the dowel bars, the concrete, or both. A clearer knowledge of this effect is of considerable importance to those who are responsible for pavement design and construction. Exactly how much misalignment is tolerable under construction? To find the answer to this question, the authors prepared and tested twenty specimen slabs, 5 and 6 in. thick, which demonstrated the action of ten contraction joints and ten expansion joints.

SOIL REACTIONS IN RELATION TO FOUNDATIONS ON PILES

A brief preview of the paper on "Soil Reactions in Relation to Foundations on Piles" by Robert M. Miller, M. Am. Soc. C.E., was published in the April issue of CIVIL ENGINEERING, and its delayed publication attests to the great care given to its preparation.

Memoirs of Deceased Members

PREPRINTS OF TRANSACTIONS, Volume 102, have now been provided, comprising the memoirs of the following deceased members:

John Capron Balcomb	1878–1936
Robert Dunn Budd	1873–1935
Charles Willis Chassaing	1872–1934
Edward Ivan Clawiter	1879–1936
Samuel Gourdin Gaillard	1853–1936
John Hislop	1856–1901
Richard Carmichael Hollyday	1859–1936
Laurence Cooper Hough	1891–1937
Conway Robinson Howard	1881–1936
John Bigger Leeper	1868–1936
Charles Patterson McCausland	1881–1936
Frank Pape McKibben	1871–1936
Vincent Phillip Odoni	1879–1936
John Melvin Reardon	1900–1936
William Fullerton Reeves	1859–1936
Charles Victor Witt	1877–1936

These memoirs are available in limited numbers to members on request to the Secretary of the Society, 33 West 39th Street, New York, N.Y.

Papers Filed in Library

SIX PAPERS have recently been deposited in the Engineering Societies Library, 29 West 39th Street, New York, N.Y., where they are available for reference. Prices for photostatic reproductions will be quoted by the library on request.

DIFFERENTIAL EQUATIONS OF DYNAMICS SOLVED BY OPERATIONAL CALCULUS

ABBETT, ROBERT W., Assoc. M. Am. Soc. C.E.: "Differential Equations of Dynamics Solved by Operational Calculus" (20 typewritten pages, and 1 sheet of diagrams). In this paper Professor Abbett demonstrates the application of the Heaviside operational calculus to problems in dynamics. A method is presented for the solution of linear differential equations having constant coefficients, which reduces the procedure to a simple algebraic operation, and eliminates entirely the difficulty of evaluating integration constants. In particular the study is limited to the behavior of simple structures initially at rest, to which forces or impulses are suddenly applied, and where the function of time is important.

STRESS TRAJECTORIES IN TRIANGULAR DAMS

BRAHTZ, J. H. A.: "Principal Stress Trajectories in Triangular Dams" (about 2,800 words, plus 6 diagrams). By means of Airy functions, equations for isoclinics and lines of principal stress in an infinite wedge subjected to hydrostatic pressure and mass forces are developed. It is pointed out that in studying the lines of principal stress it is often easier to investigate the isoclinics first, and a graphical method of determining the trajectories of principal stress from the isoclinics is presented. The paper leans somewhat on a previous one by Dr. Brahtz, "The Stress Function and Photoelasticity Applied to Dams" (Transactions, Vol. 101, page 1240, et seq.).

Orinda Filtration Plant

DeCosta, J. D., Assoc. M. Am. Soc. C.E.: "Orinda Filtration Plant, East Bay Municipal Utility District, Oakland, California" (about 7,500 words, plus 4 large drawings and 9 photographs). This paper, describing a 42-mgd filtration plant, was originally published in the *Journal of the American Water Works Association* for October 1936. The manuscript copy is somewhat more complete, with additional photographs and drawings. Features of special interest are (1) operation without pretreatment of the raw water, (2) use of "egg-crate" baffles to still the lateral flow of wash water, and (3) provisions for preventing overflow of the plant. Tabulations of hydraulic cost, and other pertinent data are included.

Influence Lines by Moment Distribution

Kruys, F., Assoc. M. Am. Soc. C.E.: "Influence Lines by Moment Distribution" (about 1,100 words, plus 2 diagrams). The author presents a method for obtaining influence lines for moments at joints in continuous frames, by means of the principles of moment distribution and superposition.

High-Pressure Reinforced Concrete Pipes

Smirnov, A.: "High-Pressure Reinforced Concrete Pipes" (about 4,200 words, plus 5 diagrams). This paper presents a method for designing concrete pipes with pre-stressed reinforcement, considering the pipe as a thin shell. Creep and shrinkage of the concrete are not taken into account. The author is a hydraulic engineer in Moscow, U.S.S.R.

Vacuumless Dam Profile

Vitols, A.: "A Contribution to the Question of the Vacuumless Dam Profile" (about 4,900 words, plus 1 table and 5 diagrams). An elaborate mathematical analysis of the problem of designing the crest of an overflow dam to avoid negative pressures. The author is a professor at the University of Riga, Latvia.

Appointments of Society Representatives

Inge M. Lyse, M. Am. Soc. C.E., has accepted an appointment to serve as one of the Society's representatives on the Division of Engineering and Industrial Research of the National Research Council for the term, June 1937–June 1940.

J. P. H. Perry, Enoch R. Needles, and Frank Winsor, Members Am. Soc. C.E., have been appointed Society representatives on the Engineers' Council for Professional Development.

Hermann Von Schrenk, M. Am. Soc. C.E., has accepted an appointment as Society representative on the Committee on Specifications for Railroad Ties of the American Standards Association.

News of Local Sections

Buffalo Section

A luncheon meeting of the Buffalo Section took place at the Buffalo Athletic Club on April 13. The feature of the occasion was the installation of the 1937–1938 officers of the Section by William P. Feeley, retiring president. A list of these officers appeared in the "News of Local Sections" department of the May issue of Civil Engineering.

Central Illinois Section

The annual "ladies night" dinner meeting of the Central Illinois Section was held in Champaign on April 22, with 48 members and guests present. Following dinner and a short business meeting, the group adjourned to the illumination laboratory of the department of electrical engineering at the University of Illinois to hear Prof. J. O. Kraehenbuehl give an interesting and instructive talk on lighting in the home.

Central Ohio Section

On April 15 the Central Ohio Section met at the Chittenden Hotel in Columbus for its monthly luncheon. There were 26 present on this occasion to hear the guest speaker, L. A. Boulay, state director of the PWA in Ohio, who gave a résumé of the organization's activities in that state and outlined his theories as to the future rôle of the PWA.

Cincinnati Section

A joint meeting of the Cincinnati Section and the University of Cincinnati Student Chapter took place on April 8, with 40 members and guests present. During the business session the tellers announced that the officers for the forthcoming year will be H. H. Schroth, president; W. W. Parks, vice-president; and W. W. Carlton, secretary-treasurer. The meeting was then turned over to the new president, who introduced the speaker of the evening, W. C. Devereaux. Mr. Devereaux, who is senior meteorologist in charge of the Cincinnati Weather Bureau, gave an interesting talk on the subject of weather and floods. A spirited discussion followed.

Cleveland Section

A luncheon meeting of the Cleveland Section was held at the Cleveland Chamber of Commerce on May 4. The speaker of the evening was John Dresser, president of the Dresser Company and formerly with the Housing Division of the PWA in Chicago and Cleveland as district manager in charge of operations. In his talk, which was on the subject of housing, Mr. Dresser stressed the problems, practicability, and the financial and social benefits of the government's slum-clearance housing projects. Several interesting comments on the subject were made by Councilman E. J. Bohn.

Colorado Section

The Colorado Section held its regular monthly dinner meeting at the Denver Athletic Club on April 12. On this occasion the speaker was the Rev. Dr. W. A. Forstall, director of the Regis College Seismology Laboratory in Denver, who gave a short history of seismology. The meeting was sponsored by the Junior Association of the Section, the committee in charge consisting of C. C. McNamara, chairman, and F. R. Cline, I. F. Richards, and A. L. Ahlf. A special luncheon meeting of the Section was held on April 26. On this occasion Walter E. Jessup, Field Secretary of the Society, discussed recent activities of the Board of Direction.

On April 26 the Junior Association of the Colorado Section held its twenty-second regular meeting. The guest speaker was H. H. Nininger, who gave an illustrated talk on the subject, "Our Stone Pelted Earth." Mr. Nininger is one of the country's outstanding authorities on meteorites.

Connecticut Section

On April 27 the annual meeting of the Connecticut Section took place at the Graduate Club in New Haven, with 39 present. Eleven of these were members of the Yale University Student Chapter. During the business session the following officers were elected for the coming year: Henry W. Buck, president; Roscoe H. Suttie, vice-president; and Joseph P. Wadhams, secretary-treasurer. The feature of the occasion was the unveiling of a memorial tablet honoring Clemens Herschel, Past-President and Honorary Member of the Society. A full account of this ceremony appears elsewhere in this issue.

Dayton Section

Members of the University of Dayton Student Chapter and students of the engineering college there acted as hosts to the Dayton Section on April 19. The group were welcomed by W. C. Tredkin, president of the University. Then four students of the engineering college—natives, respectively, of Mexico, Hawaii, Australia, and Japan—gave brief talks on conditions in their countries. Following this part of the program, members of the

Section were conducted on a tour of inspection through the civil, mechanical, and electrical engineering laboratories. Group singing was then enjoyed, and refreshments were served. Attendance at the meeting numbered 50.

DETROIT SECTION

On March 31 George R. Cooke, contract engineer of Detroit, spoke before a meeting of the Detroit Section at the Statler Hotel. Mr. Cooke's topic was "My Experiences in Tunnel Work," and the audience showed keen interest in his description of the tunnelling methods used in soft clay at a depth of 90 ft under the city of Detroit, and those used in the sand rock of St. Paul. A social hour was enjoyed at the close of the meeting. One-half of the 86 persons present were guests.

ITHACA SECTION

The Ithaca Section of the Society and the Broome Area Chapter of the New York State Society of Professional Engineers met in joint session on April 13 at the Bennett Hotel in Binghamton, N.Y. An illustrated talk on the "Development of Engineering Problems at the International Business Machine Company, of Endicott, N.Y.," was given by W. W. McDowell, assistant to the vice-president of the company. Mr. McDowell emphasized the unusual problems that must be solved in developing a complicated office machine. There were 41 present.

KANSAS CITY SECTION

A special luncheon meeting of the Kansas City Section took place at the University Club on April 23. The guest of honor was James L. Ferebee, Director of the Society and chief engineer of the Milwaukee Sewerage Commission. Mr. Ferebee, who was on his way home from the Spring Meeting of the Society, gave an interesting talk on "Modern Trends in the Disposal of City Wastes" in which he described Milwaukee's method of using waste materials as fertilizer that is sold all over the country. He also discussed the subjects of interest that came up at the meeting of the Board of Direction in San Antonio. At the conclusion of the meeting Mr. Ferebee was taken on an inspection trip to visit Kansas City's modern water plant.

METROPOLITAN SECTION

The Delaware project of the New York City water supply system was the subject of an illustrated talk presented at a meeting of the Metropolitan Section, held in the Engineering Societies Building in New York City on April 21. The speaker was Thaddeus Merriman, consulting engineer for the New York City Board of Water Supply and former president of the Section. After giving an introductory history of the project, Mr. Merriman showed slides comparing this project with the Catskill and Croton water systems. It is estimated that the first stage of the project will cost $210,000,000 and will require about seven years to complete. There were 450 present.

MILWAUKEE SECTION

On March 30 a joint meeting of the Milwaukee Section and the American Welding Society took place at the City Club, with 85 present. An instructive talk on "Arc Welding in Structural Engineering" was given by A. M. Candy. Another meeting of the Section took place on April 15. At this session Charles S. Whitney, consulting engineer of Milwaukee, discussed the work of stabilizing the bluff overlooking Lake Michigan. Mr. Whitney has been engaged by many of the owners of homes along the lake shore to provide some means of preventing the sliding of banks and damage to their property. The Section authorized the establishment of a student award similar to that given by other Sections.

NEW MEXICO SECTION

A regular meeting of the New Mexico Section took place in the State Welfare Building in Santa Fe on March 12. Numerous business matters were discussed, and the president of the University of New Mexico Student Chapter addressed the meeting briefly, inviting members of the Section to attend Student Chapter gatherings. The feature of the occasion was an interesting illustrated talk on "American Engineering Practice in the Southwest." This was given by Reginald G. Fisher, of the School of American Research, who described the various types of structures developed by Indians in the Southwest from prehistoric to modern times.

NORTHWESTERN SECTION

There were 68 members and guests present at a meeting of the Northwestern Section, held at the Town and Country Club in St. Paul, Minn., on March 26. The feature of the occasion was a talk by Ralph Budd, president of the Chicago, Burlington, and Quincy Railroad. Mr. Budd, whose subject was "The Engineer's Part in Railroad Modernization," gave a personal review of railroad history and emphasized the contribution of chemical and metallurgical engineers through their development of high-strength alloys. The meeting was one of the best the Section has had in recent years, and the large attendance was a tribute to Mr. Budd. Another meeting of the Section, held at the Minnesota Union in Minneapolis on April 13, took the form of a joint meeting with the University of Minnesota Student Chapter. During the business session the members went on record as opposing proposed changes in the state registration law. The speaker of the evening was George H. Herrold, member of the State Planning Board and managing director and engineer of the City Planning Board. Mr. Herrold, who has recently returned from a trip to Texas, discussed matters of city planning that came to his attention in that state.

PHILADELPHIA SECTION

Members of the Philadelphia Section enjoyed an inspection trip to Safe Harbor, Pa., on April 24. Following luncheon, Paul M. Hess and H. E. Whitney, respectively, operating and construction engineer for the Pennsylvania Water and Power Company, and C. F. Merriam gave talks on the Safe Harbor Hydroelectric Development and answered questions regarding special construction features. An inspection tour of the project was then made.

PITTSBURGH SECTION

Among the 150 present at the meeting of the Pittsburgh Section held on April 27 were members of the Student Chapters at the University of Pittsburgh, Carnegie Institute of Technology, and West Virginia University. The guests of honor were L. F. Bellinger, Vice-President of the Society; R. P. Davis, Director; and George T. Seabury, Secretary. All gave talks on various phases of Society affairs. The election of officers, held at this time, resulted as follows: R. P. Forsberg, president; C. M. Reppert, vice-president; C. B. Stanton, secretary-treasurer; and A. V. Karpov, N. Schein, and L. P. Blum, directors.

PORTLAND (ORE.) SECTION

A joint meeting of the Portland (Ore.) Section of the Society and the Professional Engineers of Oregon took place on April 16. During the business session it was announced that F. Kochis has been elected secretary of the Section to fill the unexpired term left vacant by Kenneth L. Coltrin's removal from the Section. An interesting talk on the arts and sciences developed by the early Mayan civilization in Central America was given by C. B. McCullough, assistant state highway engineer of Oregon. There were 112 present.

PROVIDENCE SECTION

There were 100 in attendance at a meeting of the Providence Section held in the Engineering Society Building on April 15. The speaker was E. Warren Bowden, assistant to the chief engineer of the Port of New York Authority, whose subject was the Triborough Bridge. By means of stereopticon slides, Mr. Bowden explained the conditions that made such a project necessary and then described the various types of structures comprising the bridge. A lengthy and enthusiastic discussion followed.

SACRAMENTO SECTION

During April the Sacramento Section continued its custom of having weekly luncheon meetings. On the 6th, there were 43 present to hear Charles M. Goethe, president of the Engineers' Research Council and member of the California Joint Immigration Committee, discuss the subject of "Japanese Penetration into South America." A talk on the topic, "Modernization of the Water Supply of the City of Athens, Greece," was the feature of the meeting that took place on April 13. This was given by George W. Howson, of Berkeley, Calif., who illustrated his talk with slides. There were 30 present. At the meeting held on April 20 the program consisted of the showing of three films by Fred Sprague, of the Pacific Gas and Electric Company. The first film depicted the construction of the Zeppelin hangar at Akron, Ohio; the second showed the development of power in the southern Appalachians; and the third included an ingenious exposition of the transformation of electricity into heat and light. The attendance numbered 36. The last meeting of the month took place on April 27, with 54 present. On this occasion an interesting talk on "The Relation of Modern Photography to Engineering and Science" was given by Ben Glaha, engineering photographer for the U. S. Bureau of Reclamation, who for many years has had the responsibility of obtaining continuous photographic records of the development of the Bureau's projects.

SAN FRANCISCO SECTION

Members of the San Francisco Section of the Society went to Sacramento on March 19 to attend a two-day engineers' convention, which was sponsored by the Sacramento Section. The regular meeting of the Section took place on April 20, with 260 in attendance. A colored motion picture of California highways was shown, and two speakers were heard. These were Earl L. Kelly, director of public works of California, and Charles H. Purcell, chief engineer of the San Francisco-Oakland Bay Bridge and state highway engineer.

SPOKANE SECTION

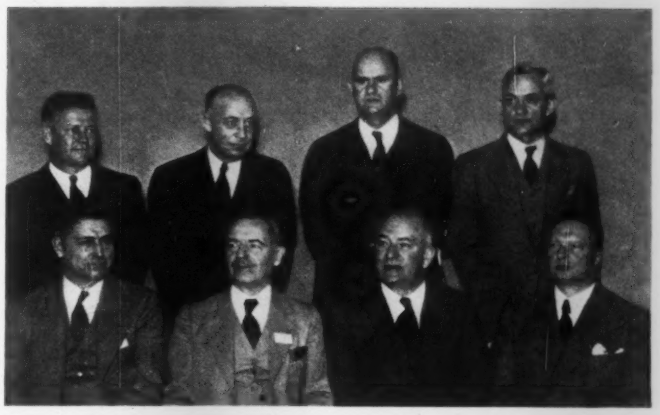
The April meeting of the Spokane Section took place at the Davenport Hotel on the 9th. There were 23 members and guests present to hear William J. Rheingans, turbine testing engineer for the Allis Chalmers Manufacturing Company, speak on the subject of the use and efficiency of the adjustable blade propeller-type turbine, with Kaplan head control. Three of these turbines were recently installed at Spokane's Upright Pumping Station.

TEXAS SECTION

Maj. William Bowie, of Washington, D.C., former chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, was a guest of honor of the Fort Worth Chapter of the Texas Section at a dinner meeting held on April 17. Major Bowie gave a talk on the subject, "Mapping the Country—Geodetic, Topographic, and Cadastral." The other guest of honor upon this occasion was R. C. Gowdy, Vice-President of the Society and chief engineer of the Colorado and Southern Railway.

VIRGINIA SECTION

A two-day meeting of the Virginia Section of the Society and local branches of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Architects and the Hampton Roads Chemists Club and the Engineers Club of Hampton Roads was held at the Monticello Hotel in Norfolk, Va., on April 30 and May 1. Following a business session on Friday morning, Prevost Hubbard, chemical engineer for the Asphalt Institute New York City, gave an illustrated lecture on asphalt. The technical program, presented at the afternoon session, consisted of papers by Alexis A. Berestneff, of the Carrier Corporation, Newark, N.J., and Walter L. Savell, of the Mathieson Alkali Works, New York City. An informal dinner was held in the evening, the speaker being Charles F. Goodrich, chief engineer of the American Bridge Company, who gave an illustrated lecture on the San Francisco-Oakland Bay Bridge. Saturday was given over to an inspection trip to the Newport News, Va., shipbuilding and dry dock company, and to the enjoyment of such places of historic interest as Williamsburg and Yorktown.



OFFICIALS AND SPEAKERS PRESENT AT JOINT MEETING

Student Chapter Notes

SOUTH DAKOTA STATE SCHOOL OF MINES

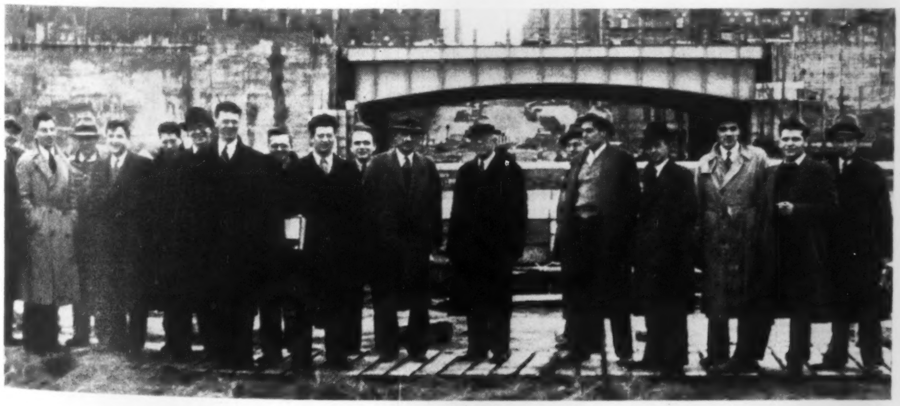
A meeting of the South Dakota State School of Mines, which took place on April 16, attracted the whole student body, the occasion being the showing of the Society's illustrated lecture on the George Washington Bridge.

UNIVERSITY OF DAYTON

The Society's illustrated lecture on aerial photography was shown to an enthusiastic audience at a recent meeting of the University of Dayton Student Chapter. A short business session preceded the showing of the film, and a question-and-answer period followed it.

UNIVERSITY OF NEBRASKA

At a meeting of the University of Nebraska Student Chapter held on April 7, Prof. E. F. Schramm, chairman of the geology department of the university, gave an interesting illustrated lecture on Mexico. He described an imaginary trip over the new Pan-American highway from Laredo, Tex., to Mexico City and then showed views of the beautiful scenery and vegetation along the highway as well as scenes from the lives of mine and oil workers in Mexico.



MEMBERS OF COOPER UNION STUDENT CHAPTER VISIT WEST SIDE IMPROVEMENT PROJECT

COOPER UNION

On April 22 the Cooper Union Student Chapter went on a field trip to inspect the West Side Improvement Project in New York City. One of the engineers on the project, who is a Cooper Union alumnus, conducted the students along the site from 72d Street, at the beginning of the future Riverside Park, to 96th Street. Among the interesting things seen in the course of this walk were the traffic circle and half clover-leaf intersection at 79th Street, which is being built for traffic on the elevated highway, and the access drive at 96th Street. Rolls of blue prints were then studied, and the trip ended with observing the steel erectors at work above 96th Street.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for July

Nearly two dozen interesting papers delivered at the Spring Meeting of the Society in San Antonio, Tex., April 21–24, 1937, are scheduled to be abstracted in the July issue of Civil Engineering. The topics discussed include the resources of Texas, both natural and man-made; highway developments in Texas and in Mexico; advances in irrigation practices; applications of modern surveying methods to the Mexican boundary line and the lands of the University of Texas; mapping the Brazos River area; construction of the new causeway at Galveston; and design of the San Jacinto memorial

As complete a treatment will be accorded each paper as space limitations will permit. It is possible that some will be selected for publication in full in Proceedings at a later date, and in such cases comparatively brief notice will be given in Civil Engineering. The disposition in every case will be determined through study by the Committee on Publications. It is hoped that the presentation of these technical papers will convey to all members some measure of the inspiration experienced by those attending the Spring Meeting

Harvard Traffic Fellowships Open

Fifteen graduate fellowships in the field of street and highway traffic control are offered by the Bureau for Street Traffic Research of Harvard University, according to a recent announcement. The fellowships are in the amount of $1,400 each, which is given by the Automobile Manufacturers Association for a year's intensive training at the university in two basic courses in traffic control and two specialized traffic courses or two approved collateral courses.

The fellowships are open to persons not over 35 years of age who have a degree representing four years' work in an accredited college or university. Applicants who now hold positions in fields related to street traffic control should obtain a leave of absence for not less than the period September 27, 1937, to June 18, 1938. The Institute of Traffic Engineers is cooperating with the bureau in the selection of Fellows, and it will be necessary for each applicant to be interviewed by at least one member of the Institute.

Applications must be returned on or before June 15, 1937, upon forms to be obtained from Maxwell Halsey, assistant director of the Bureau of Street Traffic Research, 29 Holyoke Street, Cambridge, Mass. Announcement of appointments will be made as soon thereafter as possible.

Camel Bridge at Summer Palace, Peiping, China

Beauty and Utility in Engineering Structures

As one in a series of structures depicting "Art in Engineering," this month's "Page of Special Interest" shows a stone-faced hollow-spandrel arch on a state highway in Ohio. It is the purpose of this series to further the appreciation of beauty in the finished work of the engineer by publishing some of the many fine examples which meet the requirements of esthetic design and proper setting.

Many engineering structures have been built for utility alone, and until recently it has not been realized that even a water tank, many of which have been eyesores, could be made attractive instead. The Pagoda Water Tower, Yenching University, China, published in the March number of Civil Engineering, and the Washburn Park standpipe, Minneapolis, Minn., which is to be published as one of this series in a forthcoming number, are two examples of what can be done to make a structure beautiful as well as useful.

Among the subjects that have been chosen from foreign countries to demonstrate the theme of this series is the "Camel Bridge," Summer Palace, Peiping, China, sent in by Dr. Robins Fleming. This bridge dates back to the Sui Dynasty, 590–618 A.D., and shows how the high arch necessitated by limited knowledge of materials and engineering principles was made to appeal to the eye. Present-day engineers will realize the problems entailed in the design of a 37.47-meter arch back in the sixth and seventh centuries, and will, no doubt, give due credit to the early artisan who built his structure to last for hundreds of years, to furnish lasting proof of Keats' immortal lines:

A thing of beauty is a joy forever;
Its loveliness increases; it will never
Pass into nothingness.

The Mayor Said "No"

Civil Engineering is indebted to S. L. Williamson, Jun. Am. Soc. C.E., for the following sidelight on politics versus early engineering in Charlottesville, Va.

In 1898 the city council appropriated $75 to send the superintendent of water to the American Water Works Association meeting in Boston. The mayor vetoed this in no uncertain terms:

"I return without my signature the accompanying resolution appropriating $75.00 to defray the expenses of the Superintendent of Water to a meeting of the American Water Works Association to be held in Boston.

"Our superintendent of water has no complex nor scientific work to perform that I have ever heard of.

"His duties are plain and simple. Furthermore, as we have no assistant superintendent of water, the superintendent should be in place to do his work for which he receives a salary of $1,000.00 and $144.00 for horse feed. . . .

"It is unnecessary to say that the principle is wrong and the precedent unwise, if not dangerous even if the treasury was in better shape than it is."

Apparently the turn of the century brought new light to the mayor, for in 1904 his message to the council included the following remarks:

"The most important matter for the council to consider is the water question. Its importance is so great that it cannot be magnified or exaggerated. I would suggest that you avail yourselves of the service of local or other expert service in solving this problem to the end of a wise issue of this important matter."

Bolivia's Proposed Inland Waterway

By William E. Rudolph, M. Am. Soc. C.E.

Chief Engineer, Mauricio Hochschild and Company, Ltd., La Paz, Bolivia

Mining interests of the Bolivian plateau are studying the possibility of canalizing the Rio Desaguadero, the outflow stream of Lake Titicaca. The project is still in the promotion stage, but the character of the stream and the method proposed for carrying on the dredging work make it of special interest.

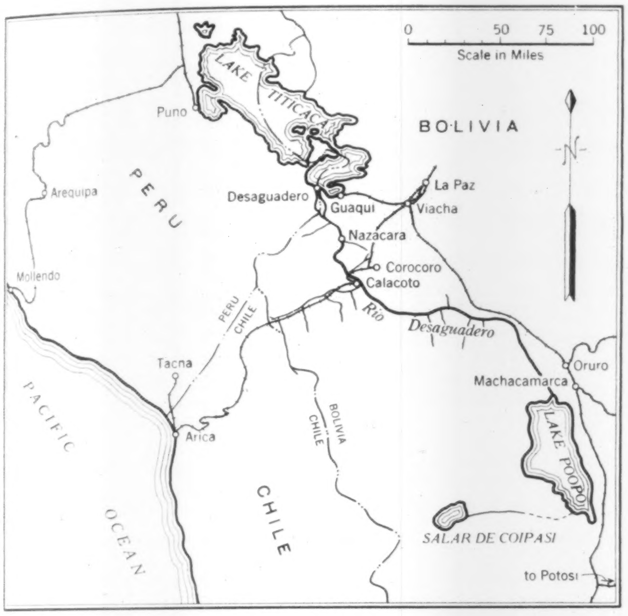


Fig 1. Parts of Bolivia, Chile, and Peru, Showing Existing Railroads and the Rio Desaguadero

At its source (Lake Titicaca, Fig. 1) the Desaguadero has a flow varying between 5,500 cu ft per sec and 700 cu ft per sec or less. During the 265 miles of its course to its outlet in Lake Poopo, it receives the waters of some twenty or thirty streams, nearly all of which are dry for part of the year. Lake Poopo is a shallow, brackish evaporating pan; of the water that enters it during the dry season, only about 200 cu ft per sec leaves it, and this flows to the Salar de Coipasa, where it is lost completely to evaporation and seepage.

It might be wondered why, with 12,000 miles of navigable waterways on its eastern slope leading to the Atlantic, Bolivia should be interested in this single short river of its high plateau which becomes lost on its way to nowhere. But Bolivia's mineral wealth is concentrated mainly within this western highland region, and its main population is also centered there because of the healthful climate. Three railroads give access to the Pacific, and merely by providing cheap transportation for certain mining products to these railroads, the little Rio Desaguadero can command more shipping than all the vast fluvial network of Bolivia's tropical forest.

The upper section of the Desaguadero was used in the latter part of the nineteenth century to carry copper minerals from the Corocoro mines to Lake Titicaca. The ore was carried in shallow-draft steel scows which were poled, or towed by mules, as far upstream as Nazacara, then pulled by flat-bottomed stern-wheel boats to the lake at Guaqui. The transport was continued to Puno by lake steamer and thence to Mollendo on the Pacific by the railroad across Peru.

In 1913, the railroad from La Paz to the port of Arica, Chile, was placed in operation and abruptly the Desaguadero passed out of the transportation picture. For 23 years it was forgotten, but now has entered the limelight again.

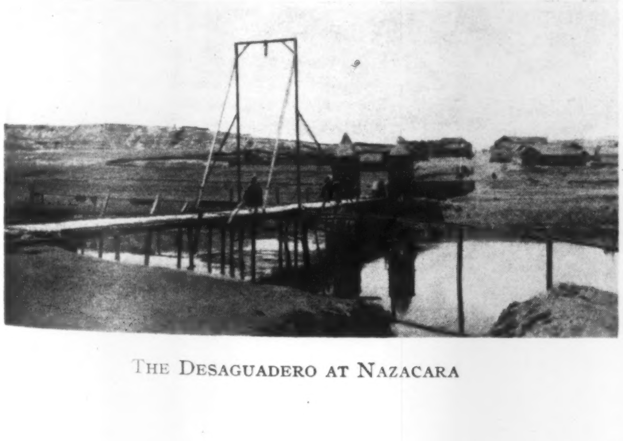
A large mill is now contemplated near the northeastern coast of Lake Titicaca, for producing zinc and lead concentrates. Shipment of such cargo by lake steamer to Guaqui, and thence by rail to Arica, would involve a long detour to Viacha. On the other hand, shipment by lake steamer to Puno and rail to Mollendo would be less advantageous because port facilities at the latter place are inferior to those prevailing in Arica.

Other mining interests to the southeast, in the vicinity of Machacamarca, are also interested in a short cut to Calacoto on the Arica Railway. It can be seen that the Desaguadero, in both its upper and lower courses, provides a route to the Arica Railway at Calacoto, which is short compared with the detours via Viacha over existing railroads.

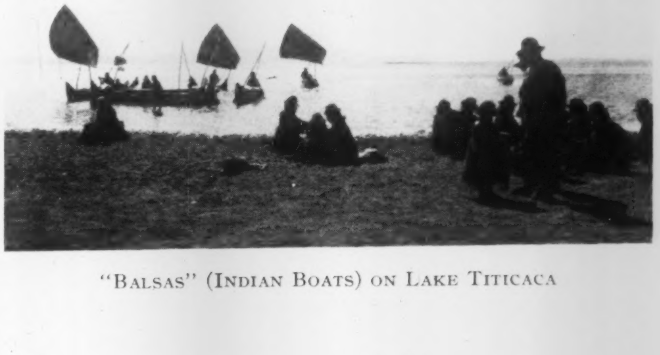
Navigation on the upper Desaguadero and that on the lower Desaguadero are two distinct projects, each with the object of bringing cargo from outlying districts to Calacoto, the convenient railroad shipping point to the Pacific. There will be little through traffic from one lake to the other.

Improvement of the upper river presents no important difficulties. In all, about 350,000 cu yd of material will have to be dredged to provide a channel 33 ft wide and 5 ft in minimum depth. The work, however, presents certain peculiarities that render it quite different from ordinary dredging problems. Floating equipment would be unsatisfactory, for the stream is so shallow that a barge of considerable size would be required, and it would be slow and expensive to maneuver. Again, the depth of excavation is so shallow—20 in. and less—that a clamshell bucket working from a barge would be inefficient. Hydraulic dredging equipment would entail capital expenditures quite out of proportion to the amount of work involved. Hence a somewhat unusual piece of equipment was decided upon—a Diesel-operated dragline with 60-ft boom, mounted on caterpillars and designed to move directly upon the river bed (Fig. 2). Where the river bed might be too soft to support the machine, mats handled by the machine itself could be laid for additional support.

The manufacturer of the machine contemplated has proposed to raise the upper works of a standard model 12 in. above standard height, so that the revolving frame will be above water when at maximum near-shore river depth (50 in.). This would be accomplished by equipping the truck frame with a cast-steel subbase, mounted between the truck frame and the rack and track. Special provision would be made for braking and



The Desaguadero at Nazacara



"Balsas" (Indian Boats) on Lake Titicaca

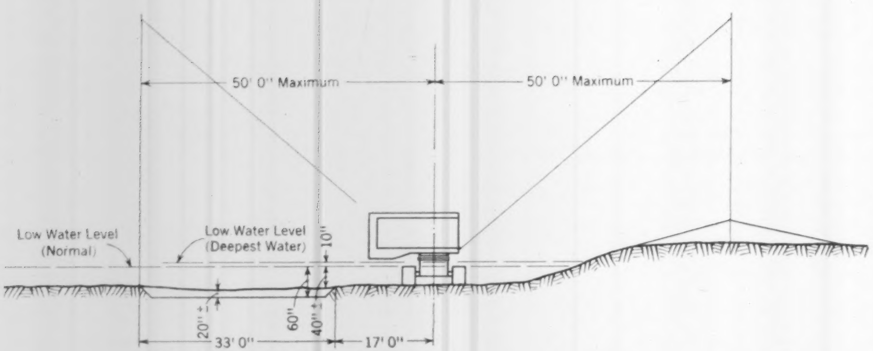


FIG. 2. A DRAGLINE DESIGNED TO OPERATE IN 50 IN. OF WATER WOULD BE USED IN EXCAVATING THE CHANNEL IN THE DESAGUADERO

lubricating the part of the machine that would operate below water, and the lower propelling bevel gears would have to be flame-hardened, or otherwise heat-treated, so as to run without lubrication under water.

Another problem in connection with canalization is to select the type of boat to be used after the project is completed. The principal cargo for the upper Desaguadero will have to make a 60-mile trip on Lake Titicaca before reaching the river, and the boats should be suitable for use in both sections. The lake is deep, and subject to storms with waves 32 in. high. On it a fair rate of speed is both feasible and desirable. The river is shallow, and has a current of 2 miles per hour. Here a speed greater than 5 miles per hour would be dangerous.

The boats now under consideration are Diesel-operated, flat-bottomed barges of about 80-ton capacity, built of plates, and having a draft of 40 in. Each motor barge would draw a scow. Hatches would be covered as on a sea vessel, and a convertible rudder would serve for either lake or river travel.

Preparation of the river for traffic below Calacoto has not yet been studied thoroughly. Dredging would be more expensive than in the upper river because of the amount of material to be removed and the presence of rock in several places.

When one considers that the Desaguadero carries so much water from Lake Titicaca during the summer months, and so little during the dry season, the importance of stream-flow regulation becomes apparent. However, construction of a dam and locks would not be a justifiable expenditure to be carried entirely by the shipping.

A dam that will maintain within certain limits the level of water in Lake Titicaca, and thus in the Desaguadero, may eventually be built as part of a power development project, already proposed but awaiting future demands for power to be brought to the construction stage. The dam at Desaguadero would hold in the lake the water that is now lost in the flood cycle of the river. A tunnel on the east side of the lake would divert 700 cu ft per sec to the eastern slope of the Andes, where a total head of 6,000 ft is available for generating power. The Rio Desaguadero would be assured a minimum flow of 1,300 cu ft per sec, which would not only permit operation of larger boats, but also would make available a fair quantity of water for irrigation.

Wise and Otherwise

SOME YEARS ago Professor Abercrombie found that the solitary window in his study no longer admitted sufficient light to accommodate his failing eyesight. As the Professor was faced with the economic problems all too common to members of engineering faculties, he wished to enlarge it at the least possible cost.

The window was a perfect square, 3 ft wide and 3 ft high. By a simple computation the Professor found that it could be enlarged to double its original area while it still remained a perfect square, 3 ft wide and 3 ft high. How was this done? (This problem was submitted by John A. Guissinger, Assoc. M. Am. Soc. C.E.)

The alterations referred to resulted in sufficient light to enable the Professor to solve the following problem in literal subtraction:

$$\begin{array}{r} \text{ABC} \\ -\text{CBA} \\ \hline *\,*\,* \end{array}$$

The remainder was found to consist of the same three digits, arranged in a third order.

In the problem for May, a scout on horseback started from the rear of a column of soldiers 4 miles long marching at the rate of 4 miles per hour, and traveled at a uniform rate to the head of the column. Having delivered a message without pausing for a moment, he reversed his direction and proceeded to the rear at the same rate. The trip was completed in exactly one hour. The scout's speed was required to be found.

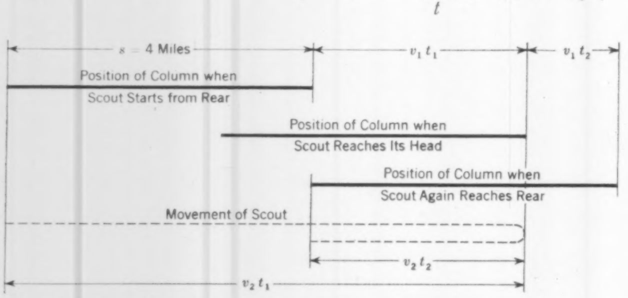

s = 4 Miles
v_1t_1
v_1t_2
Position of Column when Scout Starts from Rear
Position of Column when Scout Reaches Its Head
Position of Column when Scout Again Reaches Rear
Movement of Scout
v_2t_2
v_2t_1

FIG. 1. PROBLEM OF THE SCOUT AND THE COLUMN

Referring to Fig. 1, the following are known: Rate of march of column, v_1, equals 4 miles per hour; length of column, s, equals 4 miles; in addition, the time during which the scout goes forward, t_1, plus the time the scout goes towards rear, t_2, equals one hour. As in some other recent problems, absolute values appear to be essential, whereas only relative values need be employed. Since the scout travels at a uniform rate v_2, the time t_1 consumed in traveling forward relative to the column is $\frac{s}{v_2 - v_1}$, and the time t_2 consumed in traveling to the rear relative to the column is $\frac{s}{v_2 + v_1}$.

Then $$\frac{s}{v_2 - v_1} + \frac{s}{v_2 + v_1} = t \ldots [1]$$

Solving this equation for v_2 gives the general quadratic form,

$$v_2 = \frac{s \pm \sqrt{s^2 + v_1^2t^2}}{t} \ldots [2]$$

Substituting $s = 4$, $v_1 = 4$, and $t = 1$ in Eq. 2 gives the scout's speed as 9.657 miles per hour.

It will be noted that in the problem given, v_1 and s are equal numerically. This makes v_1t_1 equal to v_2t_2 in Fig. 1, which is an additional relationship true in this particular case but not applicable to the general problem.

Referring to the restatement in the May number of CIVIL ENGINEERING of the problem of the pursuit curve, the time consumed by the test run was incorrectly given as 2 minutes, instead of 2 minutes and 40 seconds, as appeared in the original statement. The proper figure was used in the solution, however, which is correct as printed.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

Brief Notes from Here and There

ONE HUNDRED leaders in industry and banking from all sections of the United States will be taken behind the scenes of Europe's industrial and other research this summer, on a tour arranged by the National Research Council's Division of Engineering and Industrial Research. The group will visit outstanding scientific research laboratories of private industry representing 18 major fields, as well as the laboratories of governments, universities, and trade associations, in England, Germany, and France. This is the fourth educational tour of research laboratories conducted for American executives by the National Research Council since 1930, but the first to visit foreign countries.

* * * *

The Columbus Engineers' Club recently honored F. W. Jennings and F. H. Eno, both Members Am. Soc. C.E., by electing them to honorary life membership in recognition of their long service to the club and outstanding work as engineers. The former is president of the firm, Jennings and Lawrence, consulting engineers of Columbus, and Mr. Eno is professor of highway engineering at Ohio State University.

* * * *

A Bulletin recently issued by the National Bureau of Standards, Department of Commerce, as of January 1, 1937, contains a large amount of information about hydraulic laboratory research in the United States. The principal feature is a list of current projects in hyraulic laboratories. Also included are abstracts of completed projects, a list of foreign pamphlets received by the Bureau and available for loan, and an index to the various projects arranged by subjects. A copy of the bulletin has been filed in the Engineering Societies Library.

* * * *

On June 21–26, 1937, the American Association for the Advancement of Science and associated societies will hold its one-hundredth meeting at Denver, Colo. The Association has extended to members of affiliated organizations residing in the vicinity, including those of the Society, an invitation to attend. Two Members, Ivan E. Houk and Arthur O. Ridgway, will officially represent the Society on this occasion.

NEWS OF ENGINEERS

Personal Items About Society Members

Harald M. Westergaard, Gordon McKay Professor of Civil Engineering at Harvard University, has been appointed dean of the Harvard Graduate School of Engineering. He will assume his new duties in the fall. Professor Westergaard went to Harvard last fall from the University of Illinois, where he had been professor of theoretical and applied mechanics since 1916.

Ernest P. Goodrich, consulting engineer of New York City, has accepted an offer from the Chinese Central Government to act as chief engineer in the reconstruction of the Canton harbor. Mr. Goodrich has just sailed for China, and work on the project will begin as soon as he arrives.

James H. Allen is now with the Interstate Commission on the Delaware River Basin, with headquarters in Philadelphia, Pa. He was formerly with the Allegheny County PWA at Pittsburgh, Pa.

Harrison P. Eddy, consulting engineer (Metcalf and Eddy) of Boston, Mass., was recently elected to honorary membership in the Engineering Institute of Canada. Mr. Eddy was a Director of the Society from 1928 to 1930, and in 1934 he served as President. He was awarded the Society's Norman Medal in 1925. This honor to an eminent member of the Society comes at the time when the institute is observing its semi-centennial. The award will be made on that occasion, during the current month.

Harrison P. Eddy

C. A. Broecker has been appointed engineer of qualification for the State Highway Commission of Indiana. Until recently he was assistant engineer of materials and tests for the same organization.

H. H. Hawley, designing engineer in the Bureau of Bridges of the Ohio Department of Highways, was recently elected president of the Columbus Engineers' Club.

James T. Hallett, since 1926 assistant chief engineer of the Indiana State Highway Commission, has been appointed traffic engineer for the Bureau of Traffic of the Commission.

Kenneth L. Coltrin, assistant engineer for the U. S. War Department, has been transferred from the Bonneville Project at Portland, Ore., to the U. S. District Engineer Office at Pittsburgh, Pa.

Robert W. Haselwood is now employed as soils engineer by the Los Angeles district of the Portland Cement Association. He was formerly junior highway engineer in the Materials and Research Laboratory of the California State Division of Highways.

Eugene Quiriconi, previously structural steel draftsman for the New York City Board of Transportation, has become structural draftsman for Gibbs and Hill, Inc., of the same city.

John H. Meursinge is now a reinforced concrete designer for the General Petroleum Company, of Vernon, Calif.

Samuel F. Rathvon has entered the employ of the Nevada Consolidated Copper Corporation at Hurley, N.Mex.

Marvin C. Nichols, consulting engineer of Fort Worth, Tex., has been elected president of the Texas Planning and Civic Conference. Mr. Nichols has also been appointed chairman of the Texas Chapter of the American Planning and Civic Association.

Boyd A. Bennett, formerly vice-president of the South Bay Consolidated Water Company, of Bay Shore, L.I., has been appointed president of the Northeastern Water and Electric Service Corporation, of New York City.

Edmond T. Roetman is now associated with the Bureau of Industrial Hygiene of the West Virginia State Department of Health, with headquarters at Charleston. He was previously an engineer for the Resettlement Administration at Elkins, W.Va.

Abel Wolman, chief engineer of the Maryland State Department of Health, has been made a member of the commission recently created to provide a comprehensive plan for bridge building in Maryland.

Oscar H. Horovitz is now a general partner in the Oscar H. Horovitz Company, and president and treasurer of the Horovitz Equipment Corporation, of Cambridge, Mass. These organizations specialize in steel erection equipment.

Calvin V. Davis, formerly chief engineer of the Ambursen Dam Company, New York City, has accepted an appointment as principal planning engineer for the Tennessee Valley Authority, with headquarters at Knoxville, Tenn.

Carl J. Scheve has resigned as a junior engineer in the U. S. Bureau of Reclamation in Denver, Colo., to become assistant civil engineer in the Bureau of Yards and Docks of the U. S. Navy. Lieutenant Scheve is stationed at Pearl Harbor, T.H.

Robert C. Ratcliffe has been promoted from the position of acting chief of the Department of Public Works for the City of Grand Junction, Colo., to that of chief of the Department.

Carl F. Meyer, at the close of the academic year, will return to his previous post as assistant professor of civil engineering at Worcester Polytechnic Institute. He has been serving as exchange professor of engineering at the University of Hawaii, in Honolulu.

Frank R. Burnette, formerly superintendent of construction for the American Steel and Wire Company at Cleveland, Ohio, and recently in charge of the construction of new rod mills for the company at Joliet, Ill., has been appointed assistant to the chief engineer. His headquarters are in Cleveland again.

Hiram Miller, formerly a junior engineer in the U. S. Engineer Department, New York City, has become connected with the Puerto Rico Reconstruction Administration at Ponce, Puerto Rico.

Samuel G. Keim has resigned as an instrumentman in the Oklahoma State Highway Department at Clinton, Okla., to accept a position with the National Park Service at Oklahoma City, Okla.

Mary O. Soroka is now in the U. S. Engineer Office, First District, New York City, where she is engaged in hydraulic design for flood control. She was formerly an engineer for Julian P. Friez and Sons, Inc., of Baltimore, Md.

Philip Keene, previously an associate engineer in the Inspection Division of the PWA, Washington, D.C., has become assistant chief inspector of construction for the Hudson and Manhattan Railroad, with headquarters in New York City.

Warren S. Cook, who was formerly bridge designer and shop inspector for the Iowa State Highway Commission, is now employed as a bridge designer by the Union Pacific Railroad Company. His headquarters are at Omaha, Nebr.

W. Munsey Wilson has established an engineering practice in Austin, Tex., where he will specialize in structural design for architects. He was previously assistant state engineer inspector in the Inspection Division of the PWA at Fort Worth, Tex.

Leon H. Woolsey is now connected with the Baker-Thomas Lime and Cement Company at Phoenix, Ariz. Formerly he was an engineer with the Allison Steel Manufacturing Company of the same city.

Linton E. Grinter, professor of structural engineering at the Agricultural and Mechanical College of Texas, has been appointed director of the department of civil engineering and dean of the graduate division of Armour Institute of Technology, Chicago, Ill. Dr. Grinter will take up his duties at the Institute in September of this year.

Jerome P. Gebhard, previously secretary and manager of A. C. Guetzkow, Inc., general contractors of Milwaukee, Wis., is now president and general manager.

F. H. Cothran, consulting engineer of Charlotte, N. C., has been elected president of the Piedmont and Northern Railway and the Durham and Southern Railway, with offices at Charlotte.

Taylor Holt, Jr., is now employed as structural and design engineer in the construction department of the North American Rayon Corporation at Elizabethton, Tenn. Previously he was resident engineer for the St. Emma Industrial and Agricultural Institute at Rock Castle, Va.

Howard W. Schleiter has resigned as junior cartographic engineer for the U. S. Coast and Geodetic Survey at Washington, D.C., to become connected with the Oliver Iron Mining Company at Hibbing, Minn.

George L. Opper is now president of the engineering firm of Marr, Green and Opper, Inc., of Chicago, Ill. He was formerly vice-president and secretary of the firm.

Ivan C. Crawford, dean of the college of engineering at the University of Idaho and director of the Idaho Engineering Experiment Station, was recently appointed dean of the school of engineering and architecture at the University of Kansas. Dean Crawford's appointment will become effective in the fall.

Chitty Ho is now director and chief engineer of the Chekiang Conservancy Bureau at Hangchow, China. He was previously professor of hydraulic engineering and experimental hydraulics at Pei-Yang University, Tientsin, China.

Charles Gilman, formerly vice-president of the Massey Concrete Products Corporation, New York City, is now first vice-president and general manager of this organization.

Thomas S. Burns has been made chief of the engineering section of the flood control division of the Providence District, U. S. Engineer Department. This division has charge of the flood plan for the Connecticut River. Mr. Burns was formerly principal assistant on the Denison Reservoir Project at Denison, Tex.

Ralph B. Wiley, professor of sanitary engineering at Purdue University, has been appointed head of the school of civil engineering and director of the materials testing laboratory at the University. He succeeds W. K. Hatt, a member of the faculty since 1893, who will retire at the end of the present academic year, to devote the following fifteen months to directing the highway research project handled by the University for the Indiana Highway Commission. At the end of that time Dr. Hatt will permanently retire.

DECEASED

James Bonnyman (M. '12) president of the Blue Diamond Coal Company, of Cincinnati, Ohio, died in that city on April 9, 1937. Mr. Bonnyman was born in Lexington, Ky., in 1879. In 1899, following his graduation from the University of Kentucky, he entered the employ of the Chattanooga, Rome, and Southern Railroad. From 1906 to 1912 he was, successively, treasurer, general manager, and vice-president of the Birmingham (Ala.) Coal and Iron Company. In the latter year he organized the Brookside-Pratt Mining Company, in Birmingham, of which he was president for ten years. Mr. Bonnyman went to Cincinnati in 1922 as president of the Blue Diamond Coal Company.

George Herbert Brazer (M. '09) a consulting engineer (with J. R. Worcester and Company) of Boston, died in Brookline, Mass., on April 20, 1937. Mr. Brazer, who was 64, was born in Roxbury, Mass. From 1893 to 1896 he was a rodman and transitman on surveys for sewer and street work in Roxbury and Boston; from 1896 to 1899, a transitman and draftsman on the Boston subway; and from 1899 to 1906, with J. R. Worcester, consulting engineer of Boston. During the latter period he was also engaged in designing and detailing for the Boston Elevated Railway. In 1906 he became a member of the firm, J. R. Worcester and Company. During his long connection with this firm he was engaged on some of the principal engineering projects in New England. Mr. Brazer served as a member of the Massachusetts State Draft Board during the war.

Roberto Gayol (M. '92) former consulting engineer and member of the Irrigation Board of Mexico, died on January 24, 1936. Mr. Gayol was born in Mexico on June 1, 1857, and graduated from the Escuela de Ingenieros in 1881. From 1882 to 1885 he was division engineer of the Interoceanic Railway, and from the latter year until 1892 he was city engineer of Mexico City. Later he was consulting engineer for the National Board of Health and chief engineer of the Sautena Irrigation Works. For many years he maintained a sanitary and hydraulic engineering practice in Mexico City. About five years ago he retired.

Walter Berton Grigsby (Assoc. M. '20) manager of the engineering division of Rex Cole, Inc., Long Island City, N.Y., died at his home in Brooklyn, N.Y., on April 18, 1937. He was 44. Captain Grigsby was born in Washington, D.C., and graduated from Lafayette College in 1916. From 1916 to 1917 he was with the Truscon Steel Company, of Youngstown, Ohio, and from 1917 to 1919 he served, successively, as second and first lieutenant in the U. S. Army, being with the Ninth Mounted Engineers at El Paso, Tex. Later he was made a captain in the R.O.T.C. In 1921 Captain Grigsby entered the New York office of the Truscon Steel Company—first as engineer and, later, as manager. He remained there until 1932 when he became connected with Rex Cole, Inc.

Thomas Herbert Jackson (M. '29) brigadier general, Corps of Engineers, U. S. Army (retired) died in China on April 7, 1937, while on a world cruise. He was 63. General Jackson graduated from the U. S. Military Academy at West Point in 1899. From 1907 until his retirement in January of this year he was district engineer for the U. S. War Department in various parts of the country. During the first four years of this period, while district engineer at San Francisco, Calif., he prepared a flood-control plan for the Sacramento River, developing spillways that became the prototype for the Bonnet Carré spillway on the Mississippi. From 1917 to 1919 General Jackson was chief engineer of the American forces in France, and from 1926 until his retirement he served as president of the Mississippi River Commission.

As such he was responsible for inaugurating and directing the so-called Jadwin plan of flood control on the Mississippi.

Luther Hill Kirby (Assoc. M. '18) of Santa Barbara, Calif., died on February 6, 1937, at the age of 56. Mr. Kirby was born at Lenoir, N.C., and graduated from the North Carolina State College of Agriculture and Engineering in 1910. From 1911 to 1917 he was project chief and chief of party on cadastral surveys for the U. S. Civil Service in the Philippines. During the war he served as a captain in the Engineer Officers' Reserve Corps and was assistant-construction quartermaster at Alexandria, La. Later Mr. Kirby was a civil engineer for several years for the Cupey Sugar Company at Oriente, Cuba.

Gerald Wilson Knight (M. '26) executive secretary of the Interstate Sanitation Commission, with offices in New York City, died at his home in Passaic, N.J., on April 10, 1937. He was 58. A native of Montpelier, Vt., Mr. Knight began his career in 1898 as a draftsman and engineer for various construction companies. Later he was senior designing engineer of the Toledo purification plant and chief engineer of the Pittsburgh Filter Manufacturing Company. During the war he served as captain in the Sixteenth Engineers and organized a system of water supply for the American troops in France. In 1920 Mr. Knight established a consulting practice in Passaic, which he maintained until 1936 when he was appointed executive secretary of the Interstate Sanitation Commission. For three years he was city engineer of Paterson, N.J., and he also acted as consulting engineer for the city of Newark, N.J.

Ludwig Theodore Maenner (M. '19) former office engineer for the Missouri Pacific Railroad, St. Louis, Mo., died on April 6, 1937. Mr. Maenner, who was 73, was born at Neustadt, Bavaria. From 1890 to 1903 he was a draftsman in the engineering department of the Great Northern Railway; from 1903 to 1906, chief draftsman for the Chicago, Rock Island and Pacific Railway; and from 1906 to 1909, chief draftsman for the Isthmian Canal Commission. In the latter year Mr. Maenner became connected with the Missouri Pacific Railroad as chief draftsman and, later, as office engineer. He retired in 1934.

Bradley Revere Metcalf (M. '30) city engineer of Tucson, Ariz., died on May 6, 1936, at the age of 52. He was born at Elgin, Ill., and educated at the University of California. From 1909 to 1912 Mr. Metcalf was with the city architect of San Francisco, Calif.; from 1912 to 1914, with the city engineer of Sacramento, Calif.; from 1917 to 1919, engineer for the Cochise County (Arizona) Highway Commission; from 1920 to 1922, with the Pima County (Arizona) Highway Commission; and from 1924 to 1930, senior engineer on bridge and dam design for the Los Angeles County Flood Control District. Just before his death he became city engineer of Tucson.

Jay Johnson Morrow (M. '04) brigadier general, U. S. Army (retired) died suddenly at his home in Englewood, N.J., on April 16, 1937, at the age of 67. General Morrow was born at Fairview, W.Va., and graduated from the U. S. Military Academy at West Point in 1891. In 1898, after serving as instructor at the Academy, he saw active service in the Philippines and later was military governor of the Province of Zamboanga there. He was engineer member of the Board of Commissioners for the District of Columbia from 1907 to 1909, and in 1916 he went to the Canal Zone as engineer of maintenance. During the war General Morrow was deputy chief engineer of the A.E.F. He then returned to the Canal Zone as engineer of maintenance. From 1921 until his retirement from active duty in 1924 he was governor of the Zone. From 1925 to 1929 he served as American member and chairman of the Special Committee on Boundaries in Tacna-Arica, Chile.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Walter Justin Sherman (M. '09) a retired consulting engineer of Toledo, Ohio, died there on April 15, 1937, at the age of 82. Mr. Sherman was born at Florence, Ohio, and graduated from Cornell University in 1877. He played an important part in the railroad-building boom of fifty years ago, serving more than a dozen railroads. These included the Gulf, Colorado and Santa Fe Railroad; the Dallas, Pacific and Southeastern Railroad; and the Wheeling and Lake Erie Railroad. Mr. Sherman also erected many bridges in the Middle West and supervised the construction of the Toledo water works. From 1897 to 1910 he was a member of the general engineering firm, the Riggs and Sherman Company, of Toledo, and from the latter year until his retirement in 1927 he continued practice under the name of the W. J. Sherman Company.

Kenneth Shibley (M. '23) of Seattle, Wash., died recently at the age of 55. Mr. Shibley was born at Yarker, Ontario, and educated at the University of Southern California and the University of California. From 1905 to 1912 he was with the U. S. Bureau of Reclamation, and from 1912 to 1914 he was in charge of construction for the Kierluff Company, of Los Angeles. In 1915 he became chief engineer for the California Filter Company, where he remained until 1933—from 1917 on as manager and member of the firm. In this connection Mr. Shibley was in charge of the design, construction, and sales of filtration plants and equipment.

Harry Randolph Talcott (M. '04) assistant chief engineer of the Baltimore and Ohio Railroad, died at his home in Washington, D.C., on April 6, 1937. Mr. Talcott, who was 75, was born in Richmond Va. His engineering experience included two years in the engineering department of the Chesapeake and Ohio Railroad; two years with the Southern Railroad; eight years with the Seattle, Lake Shore and Eastern (now the Seattle Division of the Northern Pacific Railroad); and four years as second vice-president in charge of operation of the Seattle Coal and Iron Company. In 1902 Mr. Talcott became engineer of surveys for the Baltimore and Ohio Railroad. Later he was made assistant chief engineer and chairman of the Valuation Committee.

Robert Bruce Tinsley (M. '17) senior civil engineer in the U. S. Engineer Office at Galveston, Tex., was killed in an automobile accident on February 24, 1937. Mr. Bruce was born in Danville, Va., on August 24, 1883, and educated at Virginia Polytechnic Institute. His early experience was in railroad work in the South. From 1909 to 1914 he was, successively, junior engineer, assistant engineer, and superintendent of construction for the Pacific Division of the Panama Canal; from 1916 to 1917, resident engineer for the Chile Export Company; from 1919 to 1924, president and general manager of the Crest Coal Company; and from 1924 to 1927, vice-president and general superintendent of the Smith Company, of Birmingham, Ala. From 1927 on he was in the U. S. Engineer Department—first at New Orleans, La., and later at Galveston. During the war Mr. Tinsley was with the 605th Engineers in France, having the rank of captain.

Paul Anthony Trost (M. '17) an engineer with George F. Hardy, of New York City, died on April 13, 1937. Mr. Trost was born in Jersey City, N.J., on March 9, 1877, and educated at the U. S. Naval Academy. In 1903, after several years in the engineering department of the International Paper Company, of New York City, he became a draftsman for George F. Hardy, consulting engineer and specialist in the pulp and paper industry. During his long career with this organization Mr. Trost supervised the design and construction of a large number of paper and pulp mills in this country and Canada.

Leonard Chase Wason (M. '03) for many years president and treasurer of the Aberthaw Company, of Boston, Mass., died on April 30, 1937. Mr. Wason was born in Brookline, Mass., on August 5, 1868, and graduated from the Massachusetts Institute of Technology in 1890. From 1891 to 1894 he was, successively, draftsman and assistant engineer of the Dominion Coal Company. In the latter year he became an engineer for the Aberthaw Company, of which he was later president and treasurer. Mr. Wason was the inventor of various items of contractors' equipment, and his firm designed and built a number of unusual and important reinforced concrete structures, including the Harvard stadium.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From April 10 to May 9, 1937, Inclusive

Additions to Membership

Abbott, Wells Osborn (Assoc. M. '36), Junior Bridge Constr. Engr., State Div. of Highways, Box 162, Independence, Calif.

Andersen, Rhuel Andrew (Jun. '37), Asst. Structural Engr., TVA (Res., 2308 North Broadway), Knoxville, Tenn.

Bailey, Samuel Major (Assoc. M. '37), Engr., U. S. Engr. Office, Custom House, Louisville, Ky.

Bannerman, Gordon Harold (M. '37), Asst. Chf. Tramway Engr., Am. Steel & Wire Co. (Res., 83 June St.), Worcester, Mass.

Bauer, Archibald Barthuly (Jun. '37), Computer, Harza Eng. Co. (Res., 2711 Sixteenth St.), Columbus, Nebr.

Bernttein, William Maurice (Jun. '37), With Columbus Heating & Ventilating Co. (Res., Y.M.C.A., Long and High Sts.), Columbus, Ohio.

Berrien, Edwin Rivers (Jun. '36), 129 North Painter Ave., Whittier, Calif.

Bjork, Wilbert Milton (Jun. '36), 2437 West 63d St., Seattle, Wash.

Bradley, Earl Huff (Assoc. M. '37), Div. Survey Chf., State Highway Comm., Box 356, Burlington, Kans.

Campbell, Joseph Garden (Assoc. M. '37), Asst. Engr., Public Works Dept., Hong Kong, China.

Cass, Walter Elmer (Jun. '36), 3720 South St., Wesleyville, Pa.

Chelazzi, Paul Caesar (Assoc. M. '36), Cons., Civ., and Structural Engr., Archt., Surv., and Land and Estate Agt., 147 Ave. Edward VII, Shanghai, China.

Conner, Stanley Jack, Jr. (Jun. '37), With Provident Mutual Life Insurance Co. (Res., 237 South 49th St.), Philadelphia, Pa.

Corbett, James Phillip (Jun. '36), Project Technician, WPA, 1315 Arthur Ave., Chicago, Ill.

Davison, Ira Milton (Jun. '37), 373 Blue Hills Ave., Hartford, Conn.

Dvořachek, William Henry (Jun. '36), 500 East Capitol St., Washington, D.C.

Ebur, Clifford Wheaton, Jr. (Jun. '37), Draftsman, Dept. of Agriculture, Washington, D.C. (Res., 661 Thirteenth Ave., Prospect Park, Pa.).

Ewald, Arden Anton, Sr. (Assoc. M. '37), Asst. Structural Engr., Dams Div., TVA (Res., 2104 Highland Ave.), Knoxville, Tenn.

Fugitt, George Lemuel (Jun. '37), Hoisington, Kans.

Gadkowski, Walter (Jun. '36), 132 Hillside Terrace, Irvington, N.J.

Gallagher, Walter Vincent (Jun. '36), General Delivery, Avalon, Calif.

Gray, Marvin Aaron (Jun. '37), 1549 Jonquil Terrace, Chicago, Ill.

Greely, James Westwood (Jun. '36), 5713 Latona Ave., Seattle, Wash.

Greenwade, Bryan Palmer (Assoc. M. '37), Asst. Engr., State Highway Dept. (Res., 319 Marshall Ave.), Port Arthur, Tex.

Hardiman, Harold James (Jun. '37), Junior Accountant, New York and Queens Elec. Light & Power Co., Long Island City (Res., 88-40 Seventy-third Ave., Glendale), N.Y.

Harley, Paul Lazern (Jun. '36), 429 East Palace Ave., Santa Fé, N.Mex.

Horn, Samuel James (Assoc. M. '37), Draftsman, P.R.R., New York, N.Y. (Res., 4 Cliffwood Pl., Metuchen, N.J.).

Izzard, Carl Frederick (Assoc. M. '36), Asst. Highway Engr., Bureau of Public Roads, Dist. 6 (Res., 1203 East 31st St.), Austin, Tex.

Jensen, Emil Christian (Jun. '36), 1809 Forty-first Ave., North, Seattle, Wash.

Komiakoff, Leo Nicholas (Jun. '37), Senior Foreman (Engr.), National Park Service, U. S. Dept. of the Interior, Elks Park Camp, Port Jervis, N.Y.

Latimer, Ellis Hanon, Jr. (Jun. '36), Okolona, Miss.

Lawrence, William Day (Jun. '36), Nepperhan St., Ardsley, N.Y.

Little, Andrew Jackson, Jr. (Assoc. M. '37), Asst. State Director, Div. of Operations, WPA for Florida (Res., 145 South West 11th Ave.), Miami, Fla.

Lofft, Henry Tuttle (Assoc. M. '37), Office Engr., TVA, Pickwick Dam, Tenn.

Lord, Herbert Overton (M. '37), Chf. Engr., Madison Met. Sewerage Dist. (Res., 717 Chapman St.), Madison, Wis.

Lum, Stanley Clark (Jun. '37), Estimator, A-J Contr. Co., Inc. (Res., 2603 Briggs Ave.), New York, N.Y.

Lusczynski, Norbert Joseph (Jun. '37), Junior Hydr. Engr., U. S. Geological Survey, 99 Grand Boulevard, Binghamton, N.Y.

MacLean, Charles Buck (Jun. '36), 76 White St., Hartford, Conn.

McNerney, John Joseph (Jun. '37), 539 West 150th St., New York, N.Y.

Mahon, Ross L'Estrange (M. '36), Sales Engr., Soulé Steel Co., San Francisco (Res., 2832 Piedmont Ave., Berkeley), Calif.

Mandeville, Richard James (Jun. '36), 152 South Washington, Casper, Wyo.

TOTAL MEMBERSHIP AS OF MAY 9, 1937

Members	5,653
Associate Members	6,100
Corporate Members	11,753
Honorary Members	24
Juniors	3,500
Affiliates	87
Fellows	1
Total	15,365

Martinez, Federico, Jr. (Jun. '36), Constr Engr., Compañia Mexicana de Petroleo "El Aguila," S.A., Apartado 86, Puerto Mexico Vera Cruz, Mexico.

Miller, John Edward (Jun. '36), Asst. Engr State Dept. of Health, Bureau of Eng., State Office Bldg., Lansing, Mich.

Moeller, Clifford Merrill (Jun. '37), With Eng. Dept., Burlington R.R., 2426 C St Lincoln, Nebr.

Newton, Dudley (M. '37), Asst. Prof. and Head of Dept. of Civ. Eng., Wayne Univ. (Res 4390 Oregon Ave.), Detroit, Mich.

Osborne, Gifford Lawson (Assoc. M. '36 County Engr., Wahkiakum County; City Engr., Cathlamet, Wash.

Park, Louis (Jun. '37), Junior Engr., U. S Govt., R A, 225 Wilson Ave., Luray, Va.

Perkins, Charles Alvin (Jun. '36), 404 Blackstone Ave., Fresno, Calif.

Peterson, James Marslowe (Jun. '36), Eng Draftsman, Forest Div., TVA, Box 174, Norris Tenn.

Phelps, Boyd Edward (Assoc. M. '37), Dist Constr. Engr., State Highway Comm. (Res 1109 Jackson St.), La Porte, Ind.

Pritchard, Elmer Marion (Jun. '36), Brady Tex.

Robinson, James Burnham (Jun. '37), With Carrier Corporation (Res., 134 Johnson Ave Newark, N.J.

Rountree, Jack Roberts (Jun. '37), Junior Eng. Draftsman, TVA (Res., 2513 Park View Ave.), Knoxville, Tenn.

Rover, John (Jun. '36), 237 East 15th St Brooklyn, N.Y.

Sanger, Frederick James (Assoc. M. '37 Head, Dept. of Eng. and Building, The Lester School and Henry Lester Inst. of Technical Education, Shanghai, China.

Shaler, Clair Alfred (Jun. '36), With Toledo Terminal R.R. (Res., 1774 Ottawa Drive Toledo, Ohio.

Simatovich, Anthony Patrick (Jun. '37 Junior Highway Engr., U. S. Bureau of Public Roads, Room 426, Federal Office Bldg., San Francisco, Calif.

Sjostrom, Robert McDowell (Jun. '37), With E. J. Albrecht Co. (Res., 6204 South Maplewood Ave.), Chicago, Ill.

Stallworth, Thomas William (Jun. '36), Asst Office Engr., State Highway Dept. (Res., 42 Frank St.), Lufkin, Tex.

Tarr, Ernest Albert (Jun. '37), Chf. of Party State-Wide Highway Planning Survey (Res 2105 I St.), Sacramento, Calif.

Triay, Charles Roland, Jr. (Jun. '37), Surveyor's Aide, Dept. of Water and Power, City of Los Angeles (Res., 5011 South Budlong Ave Los Angeles, Calif.

Underhill, Henry Willits (Jun. '37), Jericho N.Y.

Vanden Berg, John Lloyd (Jun. '36), 856 Harbor Ave., Grand Haven, Mich.

Wetzel, Charles Maynard (Jun. '36), Junior Draftsman, State Dept. of Highways, 425 Sheridan St., Williamsport, Pa.

Winkler, Albert Lawson (Jun. '37), Chairman, P.R.R., Chf. Engr's. Office, Pittsburgh (Res., Springton Manor, Springton and Garrett Rd., Upper Darby), Pa.

Membership Transfers

Bergendoff, Ruben Nathanial (Jun. '23; Assoc. M. '28; M. '37), Asst. Engr., Ash-Howard-Needles & Tammen, 1012 Baltimore Ave. (Res., 320 East Dartmouth Rd.), Kansas City, Mo.

Bogardus, Theodore S. (Jun. '28; Assoc. M. '37), Asst. City Engr., City Hall, Meadville, Pa.

Chellis, Robert Dunning (Assoc. M. '28; M. '37), Structural Engr., Stone & Webster Eng. Corporation, 49 Federal St., Boston, Mass.

Eager, William Lyle (Jun. '27; Assoc. M. '37), Asst. to Materials Engr., U. S. Bureau of Public Roads, Dist. 3, 237 Custom House Bldg., Denver, Colo.

Eckhard, George Frederick (Assoc. M. '20; M. '37), Dean, Coll. of Eng., Univ. of Vermont (Res., 178 Summit St.), Burlington, Vt.

Flickinger, Lloyd Henry (Jun. '28; Assoc. M. '37), Asst. Engr., Minneapolis-St. Paul San. Dist., St. Paul (Res., 4040 Longfellow Ave., Minneapolis), Minn.

Freel, Wilfred Isaac (Jun. '26; Assoc. M. '36), Instr., Civ. Eng., Purdue Univ., La Fayette (Res., 331 Lawn Ave., West Lafayette), Ind.

Meyer, Otto Herman (Jun. '31; Assoc. M. '37), Asst. Engr., U. S. Engr. Dept., U. S. Engr. Office, 3038 Drummond St., Vicksburg, Miss.

Perry, John Edwin (Assoc. M. '19; M. '37), Asst. Prof., Railroad Eng., Cornell Univ. (Res., 952 East State St.), Ithaca, N.Y.

Pillsbury, Arthur Francis (Jun. '30; Assoc. M. '37), Junior Irrig. Engr., Univ. of California Citrus Experiment Station, Riverside, Calif.

Plummer, Fred Leroy (Assoc. M. '28; M. '37), Cons. Engr.; Associate Prof., Structural Engr., Case School of Applied Science, Cleveland, Ohio.

Prichard, Mason Carter (Assoc. M. '32; M. '37), Senior Engr., Office, Chf. of Engrs., U.S.A., Room 2818 Munitions Bldg., Washington, D.C.

Reeves, Arthur Blaine (Assoc. M. '29; M. '37), Engr., U. S. Bureau of Reclamation, 440 Custom House Bldg., Denver, Colo.

Solomon, Morton (Jun. '31; Assoc. M. '36), Engr., P. J. Carlin Constr. Co., 405 Lexington Ave., New York, N.Y.

Will, Curt Hesse (Jun. '27; Assoc. M. '37), Senior Engr., Jensen, Bowen & Farrell, 209 Michigan Theatre Bldg., Ann Arbor, Mich.

Reinstatements

DeFrees, Raymond Garfield, Assoc. M., reinstated Mar. 30, 1937.

Koenitzer, Lester Henry, Assoc. M., reinstated Mar. 15, 1937.

Trueblood, Paul McGeorge, M., reinstated Apr. 12, 1937.

Walker, George Alan, Assoc. M., reinstated Mar. 11, 1937.

Resignations

Allen, Mark Lawrence, Jun., resigned April 8, 1937.

Butler, Roy Graham, Assoc. M., resigned Apr. 5, 1937.

Hazard, Henry New, Assoc. M., resigned Apr. 19, 1937.

Karstetter, John Jacob, Assoc. M., resigned Apr. 29, 1937.

Kimmel, Alfred Stephen, Jun., resigned Apr. 19, 1937.

Mobberly, Henry Peyton, M., resigned April 12, 1937.

Ryder, John Marvin, Assoc. M., resigned Apr. 8, 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

June 1, 1937 Number 6

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years †	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Badgett, Stephen Harris, Jr., Troy, N.Y. (Age 23.) Graduate student, Rensselaer Polytechnic Inst. Refers to T. R. Lawson, H. O. Sharp.

Barnes, Bertram Soules, Davenport, Iowa. (Age 40.) With U. S. Weather Bureau as Supervisor of Hydrologic Work, Upper Mississippi Basin. Refers to G. H. Canfield, W. E. Dickinson, N. C. Grover, R. G. Kasel, H. D. McGlashan, C. G. Paulsen, K. N. Phillips.

Barr, James Chester, Huntington Park, Calif. (Age 57.) Engr. Examiner, FEA of PW, Los Angeles. Refers to H. K. Boone, O. E. Carr, A. H. Koebig, Jr., B. I. Means, A. J. Wagner.

Britzius, Charles Wesley, Minneapolis, Minn. (Age 25.) Graduate student and Asst. in Highway Eng., Univ. of Minnesota. Refers to F. Bass, A. S. Cutler.

Capen, Charles Herbert, West Orange, N.J. (Age 41.) Engr., North Jersey Dist. Water Supply Comm. Refers to W. G. Bank, H. Y. Critchlow, L. H. Enslow, J. E. Garratt, S. Gordon, H. N. Ogden, C. G. Wigley.

Carroll, Robert James, Columbus, Ohio. (Age 23.) Draftsman, The Jeffrey Mfg. Co. Refers to G. E. Large, C. T. Morris, J. R. Shank, C. E. Sherman, R. C. Sloane.

Cole, Willard Earl, Pasadena, Calif. (Age 27.) Hydrographer, Los Angeles County Flood Control Dist. Refers to P. Baumann, F. J.

Cornick, F. H. Hay, A. S. Kemman, F. B. Laverty, W. J. Wood.

CONNOR, THOMAS ROWLEY, Cleveland, Ohio. (Age 45.) Senior Asst. Engr., Dept. of Public Utilities, Div. of Water. Refers to J. W. Ellms, G. W. Hamlin, L. L. Holland, W. H. Knox, A. G. Levy, J. E. A. Linders.

COUNT DE LENZI ZBINDEN, ALEXIS PAVLOVICH, Brooklyn, N.Y. (Age 53.) With PWA, New York City. Refers to J. H. Angen, S. Hardesty, C. W. Keuffel, J. O. MacFeeters, C. P. Melioransky, H. T. Welty.

CRIPPEN, GLENN EDWARD, Denver Colo. (Age 27.) Jun. Engr., U. S. Bureau of Reclamation. Refers to T. R. Agg, R. A. Caughey, A. H. Fuller, J. J. Hammond, F. Kerekes, H. W. Tabor.

DODDS, GRANT CALNON, Lancaster, N.Y. (Age 24.) Draftsman, Lackawanna Steel Constr. Corporation. Refers to W. H. Allison, W. J. Farrisee, A. A. Jakkula, L. C. Maugh, F. C. Wilson.

DRUSCHEL, RUSSELL HENRY, Pittsburgh, Pa. (Age 33.) Surveyman, U. S. Engr. Office, on general hydraulic and construction engineering, Hydr. Research Laboratory, Carnegie Inst. of Technology. Refers to L. C. McCandliss, L. W. McIntyre, P. A. Perrin, E. P. Schuleen, H. A. Thomas, J. T. Whitney.

DUGGINS, CHARLES STUART, Richmond, Va. (Age 34.) Engr. Examiner, FERA of PW. Refers to C. E. Dexter, T. Ellett, A. W. Harman, R. S. Hummel, R. S. Royer, H. G. Shirley, M. A. Warthen.

ELLIS, RICHARD, Seattle, Wash. (Age 51.) Dist. Engr., Northwestern Dist., The Austin Co. Refers to W. R. Engstrom, R. A. Huestis, E. B. Hussey, R. M. Murray, M. O. Sylliaasen.

ENGSTRUM, THOMAS GEROLD, San Francisco, Calif. (Age 33.) Bldg. Inspector, Public Utilities Dept., San Francisco Bay Exposition, Yerba Buena Shoals. Refers to H. P. Cortelyou, B. K. Curry, G. A. Greene, W. T. Haight, R. F. Lauenstein, J. H. Turner, D. R. Warren.

FRIEND, HAROLD LLOYD, Washington, D.C. (Age 40.) Asst. Engr., U. S. Forest Service. Refers to A. L. Anderson, R. S. Henderson, C. S. Kirkpatrick, A. A. Miller, T. W. Norcross, W. R. Spencer, W. H. Vance.

HAGEMEYER, WALTER GEORGE, Springfield, Ill. (Age 34.) Asst. Highway Engr., Bureau of Maintenance, Illinois Div. of Highways. Refers to H. B. Belford, R. R. Benedict, C. E. Morgan, F. T. Sheets, C. M. Slaymaker, F. Tarrant, C. C. Wiley.

HAMILTON, TABER, JR., Philadelphia, Pa. (Age 27.) Inspector, Pennsylvania R. R. Electrification. Refers to C. T. Bishop, T. Crane.

HANSON, ROSS ARNOLD, Little Rock, Ark. (Age 50.) Engr.-Economist, Resettlement Administration, U. S. Dept. of Agriculture. Refers to O. G. Baxter, C. S. Christian, J. A. Harman, A. E. Heagler, G. H. Matthes, J. R. Rhyne, N. H. Sayford, J. E. Smith, G. A. Watkins.

HART, CLARENCE EUGENE, Bangor, Me. (Age 32.) Teacher, Bangor High School. Refers to W. J. Backes, P. L. Bean, H. S. Boardman, C. Dillenbeck, W. S. Evans, E. H. Sprague.

HARVEY, ELBERT HUEY, Maysville, Ky. (Age 40.) County Road Engr., Mason County, Ky. Refers to J. F. Grimes, C. W. Lovell, H. D. Palmore, M. D. Ross, E. N. Todd.

HEMBORG, RICHARD EDWIN, Los Angeles, Calif. (Age 33.) With Dept. of Water and Power, City of Los Angeles, on hydraulic studies, steel inspection, surveys, etc. Refers to S. A. Evans, W. W. Hurlbut, D. A. Lane, S. B. S. Nelson, J. E. Phillips, R. R. Proctor, H. A. Van Norman, W. W. Wyckoff.

HOLMES, GLENN WILLIAM, Washington, D.C. (Age 27.) Asst. Hydr. Engr., Sec. of Water and Hydrologic Studies, Div. of Research, Soil Conservation Service, U. S. Dept. of Agriculture. Refers to A. L. Fales, H. W. Hobbs, G. D. Holmes, C. S. Jarvis, H. W. King, E. F. O'Brien, C. E. Ramser.

HUGHES, PHILIP JOHNSON, Frankfort, Ky. (Age 32.) Refers to D. H. Bray, W. P. Eckerle. P. D. Gillham, J. T. Madison, W. W. Sanders.

HUNT, BLAIR TOFFELMIRE, Grove City, Pa. (Age 38.) Res. Engr., Allied Eng. Corporation, Canton, Ohio. Refers to C. Ash, G. L. Coyle, G. H. Elbin, F. P. Graham, N. S. Sprague.

JOHNSON, JOHN WILLIAM, Buffalo, N.Y. (Age 31.) Jun. Engr., Asst. to Directing Engr., Buffalo Sewer Authority. Refers to F. J. Downing, J. W. Fortenbaugh, S. A. Greeley, P. Hansen, G. S. Minniss, J. E. Perry, E. G. Speyer, G. J. Summers.

JOSLYN, RAYMOND JOSEPH, Davenport, Iowa. (Age 26.) Asst. Field Engr., United Light & Power Eng. & Constr. Co. Refers to A. S. Hathaway, G. A. Maney.

KAHL, WILLIAM ROE, Great Kills, N.Y. (Age 26.) Rodman, Baltimore & Ohio R.R. Refers to T. F. Comber, Jr., T. F. Hubbard, H. A. Lane, F. W. Medaugh, J. T. Thompson.

KARP, ALFRED, Mattapan, Mass. (Age 24.) Under Eng. Aide, U. S. Engr. Office, Providence, R.I. Refers to H. P. Burden, F. N. Weaver.

KAYAYAN, BEDROS, Kurtulus, Istanbul, Turkey. (Age 29.) Refers to J. S. Crandell, H. Cross, W. C. Huntington, F. E. Richart, E. S. Sheiry.

KEEFER, THOMAS SMYTH, JR., Philadelphia, Pa. (Age 28.) With E. H. Keefer & Son, Gen. Constrs. for building construction. Refers to S. B. Lilly, D. B. Zentmyer.

KETTERING, CHARLES FRANKLIN, Detroit, Mich. (Age 60.) Vice-Pres. and Director, Gen. Motors Corporation, Pres. and Director, Gen. Motors Research Corporation, and C. F. Kettering, Inc., and officer in many other companies. Refers to A. Dow, G. H. Fenkell, M. R. Fisher, W. C. Hirn, L. G. Lenhardt, R. L. McNamee, M. F. Ohr, H. E. Riggs, L. C. Wilcoxen.

KJELLMAN, VICTOR HARRY, Boston, Mass. (Age 29.) Student Engr., Engr. Corps, War Dept. Refers to J. E. Allen, F. P. Fifer, F. J. Nebiker, R. M. Strohl.

LOWE, JOHN, III, Cambridge, Mass. (Age 21.) Graduate student, Massachusetts Inst. of Technology. Refers to T. R. Camp, R. E. Goodwin, J. S. Peck, T. H. Prentice, J. C. Rathbun, K. C. Reynolds, W. L. Willig.

LUMPKIN, LLOYD EARL, Little Rock, Ark. (Age 39.) Southern Service Mgr., Marquette Cement Co. Refers to W. D. Dickinson, J. R. Fordyce, N. B. Garver, D. A. MacCrea, J. M. Page, G. A. Watkins, W. W. Zass.

MCALPIN, GEORGE WASHINGTON, Charleston, W.Va. (Age 48.) Highway Planning Engr. in charge of Planning Div., State Road Comm. of West Virginia. Refers to C. P. Fortney, C. E. Hammell, G. H. Hill, J. T. Moore, T. A. Polansky, J. L. Richmond, B. H. Simpson.

MCGINNITY, WILLIAM JAMES, Buffalo, N.Y. (Age 33.) Engr., Special Agt., Div. of Investigations, PWA, New York City. Refers to J. W. Cardwell, F. E. Fahy, A. R. O'Reilly, E. W. Seemann, C. L. Weir.

MERCADO Y DE AGUILAR, FRANCISCO VAZQUEZ DEL, Mexico City, Mexico. (Age 37.) Executive Commr., Comision Nacional de Irrigacion of Mexico. Refers to F. C. Carstarphen, T. Human, Jr., J. S. Kunkel, A. Peimbert, A. Weiss, C. P. Williams.

MOTTIER, CHARLES HELVETIUS, Chicago, Ill. (Age 49.) Eng. Asst., reporting to Vice-Pres., Illinois Central R.R. Refers to T. L. Condron, R. H. Ford, G. W. Hand, F. E. Morrow, A. F. Reichmann, A. N. Talbot, F. L. Thompson.

NAGEL, WILLIAM BROCK, Dayton, Ohio. (Age 25.) Jun. Procurement Inspector, Material Div., U. S. Army Air Corps. Refers to E. O. Bergman, C. L. Eckel, E. W. Raeder, W. H. Thoman.

OPDYKE, JOHN BENJAMIN, Rahway, N.J. (Age 27.) Instructor in Mech. Eng., Newark (N.J.) Coll. of Eng. Refers to P. S. Boughton, H. N. Cummings, S. F. Greenhalgh, W. S. LaLonde, Jr., H. N. Lendall.

PATTERSON, THOMAS SHAFFER, State College, Pa. (Age 53.) Associate Prof., Pennsylvania State College. Refers to P. B. Breneman, J. T. Campbell, J. N. Chester, J. F. Laboon, R. L. Sackett, H. B. Shattuck, E. D. Walker.

PRATT, LAWRENCE FULLER, Knoxville, Tenn. (Age 30.) Eng. Draftsman, TVA. Refers to H. H. Block, A. S. Fry, G. T. Grove, T. P. Pendleton, C. C. Reams.

PUFFER, LOUIS BLACKMER, Burlington, Vt. (Age 50.) Prof. of Civ. Eng., Univ. of Vermont. Refers to E. R. Cary, L. W. Clark, T. W. Dix, G. F. Eckhard, T. R. Lawson, A. T. Safford, H. O. Sharp, E. R. Wiseman.

RAY, OLIVER ADAM, St. Louis, Mo. (Age 23.) Engr. with W. W. Horner, Cons. Engr. Refers to E. E. Bloss, W. W. Horner, H. Shifrin, E. O. Sweetser.

ROBERTSON, UNION BANNER, Santa Fe, N.Mex. (Age 37.) Bridge Engr., U. S. Dept. of Agriculture, Bureau of Public Roads. Refers to A. L. Alin, J. P. Church, L. F. Copeland, R. A. Klein, J. D. K. Lyman, L. C. Rockett, R. M. Strohl.

SCHNEIDER, ALFRED WILLIAM, Wauwatosa, Wis. (Age 36.) Gen. Supt. and Supervising Engr., B. A. Froemming Co. Refers to J. D. Bonness, R. H. Cahill, W. F. Cavanaugh, L. D. Knapp, E. K. Knebes, W. R. Reuter, C. R. Weymouth.

SCHWESER, GILBERT CONSTANT, Chadron, Nebr. (Age 25.) Senior Foreman (Civ. Engr.), National Park Service. Refers to M. I Evinger, H. J. Kesner.

SIMMONS, JOHN WILHELM, JR., Harrisburg, Pa. (Age 49.) Associate Highway Bridge Engr., Bureau of Public Roads, U. S. Dept. of Agriculture. Refers to L. Bush, M. Goodkind, D. A. Keefe, L. A. Robb, S. W. Stewart.

SIMPSON, RALPH ERVIN, Indianapolis, Ind. (Age 44.) Salesman, Lone Star Cement Corporation. Refers to H. O. Garman, J. T. Hallett, W. K. Hatt, E. W. James, F. Kellam, W. A. Knapp, L. V. Sheridan, W. J. Titus, C. E. Vogelgesang, J. T. Voshell, J. W. Wheeler.

SIMPSON, WILLIAM MCCRAY, College Station, Tex. (Age 23.) Graduate Asst., Agricultural & Mechanical Coll. of Texas. Refers to J. F. Brookes, N. E. Wolfard.

STIENE, ROBERT MARION, Ft. Peck, Mont. (Age 24.) Student Engr., U. S. Eng. Dept. Laboratory. Refers to R. A. Anderegg, H. B. Luther, R. W. Renn, N. T. F. Stadtfeld, H. L. Weil.

STOLK, EDGAR PARDO, Caracas, Venezuela. (Age 32.) Tech. Director Ministry of Public Works. Refers to E. Aguerrevere, J. M. Bayot, V. de Chelminski, J. M. Ibarra Cerezo, J. R. Stubbins, F. J. Sucre.

TREWHITT, WAYNE DOUGLAS, JR., San Francisco, Calif. (Age 28.) With Easley & Brassy as supt. in charge of work. Refers to C. Derleth, Jr., R. P. Easley, B. A. Etcheverry, C. G. Hyde, B. Jameyson.

TROXELL, WILLARD WILSON, Baltimore, Md. (Age 44.) Industrial Economist, Resettlement Administration, U. S. Dept. of Agriculture, Washington, D.C. Refers to H. H. Allen, J. E. Greiner, W. W. Pagon, G. J. Requardt, E. B. Whitman.

VANDEVANTER, ELLIOTT, Washington, D.C. (Age 49.) Major, Corps of Engrs., U. S. Army, in charge of Marine Design Sec. of Office, Chf. of Engrs., including accident prevention work of the Engr. Dept. Refers to F. E. Barnes, F. A. Barnes, W. E. R. Covell, B. L. Crozier, E. L. Daley, W. Gerig, J. V. Hogan, G. J. Requardt, H. G. Shirley.

VAN DYKE, ALFRED JOHN, Ft. Worth, Tex. (Age 30.) Res. Engr., Texas Highway Dept.

Refers to D. H. Askew, T. E. Bliss, C. T. Holmes, W. O. Jones, D. L. Lewis, F. E. Lovett, M. C. Welborn.

Vom Saal, Walter Rudolf, Washington, D.C. (Age 26.) Jun. Civ. Engr., Resettlement Administration, Constr. Div., U. S. Govt. Refers to H. W. Bressler, P. W. Clogston.

Wallis, William Richard, Cheyenne, Wyo. (Age 30.) Bridge Designer, Wyoming State Highway. Refers to W. H. Fisher, R. D. Goodrich, E. K. Nelson, H. T. Person, N. Williams.

Wallis, William Russell, Jr., Memphis, Tenn. (Age 28.) Chf. of Party on channel inspection and survey boat, Dredging Sec., U. S. Engr. Office. Refers to F. L. Dye, Jr., H. S. Gladfelter, D. M. McCain, H. V. Pittman, B. A. Ross.

Walseth, Erling Sanborn, Riverside, Calif. Structural Draftsman, Riverside Cement Co. Refers to H. B. Blodgett, H. S. Carter, F. J. Converse, R. R. Martel, W. W. Michael, F. Thomas.

Watford, Troy Ellis, Gadsden, Ala. (Age 34.) City Engr. Refers to A. C. Decker, F. H. Frasuer, R. G. Hicklin, G. R. Kavanagh, J. H. Mayer.

Wegman, Leonard Samuel, New York City. (Age 26.) Senior Engr., Chf. of Reports Sec., WPA., Dept. of Docks. Refers to R. E. Goodwin, T. H. Jones.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Bryant, Charles Byrn, Assoc. M., Belle Haven, Alexandria, Va. (Elected Junior Dec. 14, 1925; Assoc. M. Aug. 26, 1929.) (Age 36.) Engr. of Tests, Southern Ry. System. Refers to W. T. Ballard, H. F. Clemmer, G. L. Hall, R. Lacy, P. G. Lang, Jr., H. G. Perring, R. M. Reindollar, G. J. Requardt, J. T. Thompson, A. Wolman.

Bryant, Edward Kendall, Assoc. M., Mt. Holly, N.J. (Elected July 14, 1930.) (Age 35.) Engr. for various townships in Burlington County, N.J., also for private clients. Refers to F. L. Branin, J. N. Brooks, L. W. Clark, H. T. Critchlow, C. E. Elmendorf, T. R. Lawson, W. S. Lozier.

Eriksen, Edward Leerdrup, Assoc. M., Ann Arbor, Mich. (Elected Jan. 15, 1923.) (Age 51.) Prof. and Head of Dept. of Eng. Mechanics, Univ. of Mich. Refers to J. H. Cissel, L. M. Gram, W. K. Hatt, O. A. R. V. Jensen, H. E. Riggs, R. H. Sherlock, J. A. Van den Broek.

Forbes, Hyde, Assoc. M., San Francisco, Calif. (Elected Junior Oct. 10, 1916; Assoc. M. Jan. 19, 1920.) (Age 47.) Cons. Engr. and Geologist. Refers to H. W. Dennis, H. D. Dewell, B. A. Etcheverry, H. L. Haehl, F. C. Herrmann, W. L. Huber, T. H. Means.

Guy, Leonard Thomas, Assoc. M., Melbourne, Vic., Australia. (Elected Junior May 28, 1923; Assoc. M. June 1, 1925.) (Age 40.) With State Electricity Comm. of Victoria, as Asst. to Civ. Engr., and in executive charge of hydroelectric investigations in Victoria. Refers to H. P. Boardman, L. R. East, A. L. Galbraith, B. M. Hellstrom, C. H. Kernot, C. W. N. Sexton.

Hallett, James Tilford, Assoc. M., Indianapolis, Ind. (Elected July 11, 1921.) (Age 45.) Traffic Engr., Indiana State Highway Comm. Refers to M. R. Keefe, F. Kellam, R. L. McCormick, W. J. Titus, J. W. Wheeler.

Harvey, Foster Warren, Assoc. M., Jefferson City, Mo. (Elected Nov. 23, 1931.) (Age 37.) With Missouri State Highway Dept., Bureau of Bridges. Refers to C. W. Brown, C. S. Harper, J. I. Parcel, J. I. Quinn, S. M. Rudder, H. C. Tammen.

McIntosh, William Roscoe, Assoc. M., Louisville, Ky. (Elected Jan. 14, 1929.) (Age 35.) Associate Prof. of Civ. Eng., Speed Scientific School, Univ. of Louisville. Refers to W. M. Caye, F. C. Dugan, R. E. Hutchins, R. L. McCormick, G. B. Merchant, G. R. Smiley, W. B. Wendt.

Mangan, John William, Assoc. M., Camp Hill, Pa. (Elected June 9, 1930.) (Age 40.) Dist. Engr., U. S. Geological Survey, Harrisburg, Pa. Refers to N. C. Grover, A. W. Harrington, O. W. Hartwell, J. C. Hoyt, L. Lee, C. G. Paulsen.

Noble, Charles MacIntosh, Assoc. M., New York City. (Elected June 6, 1927.) (Age 40.) Asst. Engr., The Port of New York Authority. Refers to O. H. Ammann, L. E. Andrews, H. Cook, A. Dana, R. A. Meeker, R. Smillie.

Van Hagan, Leslie Flanders, Assoc. M., Madison, Wis. (Elected June 6, 1911.) (Age 58.) Prof. of Ry. Eng., Univ. of Wisconsin. Refers to J. Donohue, J. L. Ferebee, D. W. Mead, W. A. Peirce, F. E. Turneaure, C. N. Ward.

Van Hook, Elliott Boyd, Assoc. M., Philadelphia, Pa. (Elected Junior Dec. 4, 1922; Assoc. M. Nov. 11, 1929.) (Age 39.) Structural Designer, E. I. Du Pont de Nemours & Co., Wilmington, Del. Refers to S. W. Sawin, H. S. Stanton, E. D. Walker, J. L. Warner, J. H. Wickersham.

Vogel, Herbert Davis, Assoc. M., Schofield Barracks, Oahu, Hawaii. (Elected Oct. 24, 1932.) (Age 36.) Capt., Engr. Corps, U. S. Army, being Company Commdr. in charge of road and building construction, Operations Officer, etc. Refers to G. R. Clemens, C. Derleth, Jr., C. G. Hyde, H. Kramer, G. H. Matthes, P. S. Reinecke.

Wang, Woodson, Assoc. M., Nanking, China. (Elected April 22, 1935.) (Age 39.) Chf., Designing Dept., Hydr. Eng. Bureau, National Economic Council. Refers to H. Y. Chang, S-T. Hsu, T. King, S-T. Li, H. H. Ling.

From the Grade of Junior

Blake, Paul, Jun., Lookout Mountain, Tenn. (Elected Dec. 3, 1928.) (Age 32.) Topographic Engr., U. S. Geological Survey. Refers to C. L. Allen, C. M. Cade, M. J. Gleissner, M. J. Harden, T. P. Pendleton, J. G. Staack.

Browning, Claud Franklin, Jun., Washington, D.C. (Elected Oct. 10, 1927.) (Age 32.) Public Health Engr., Consultant, Dist. of Columbia Health Dept. Refers to L. V. Carpenter, R. P. Davis, L. M. Fisher, A. P. Miller, G. E. Parsons.

Calvert, John Thornton, Jun., London, England. (Elected Aug. 13, 1934.) (Age 29.) Chemist, Bacteriologist and Eng. Asst., John Taylor & Sons, Chartered Civ. Engrs., London, and Personal Asst. to Godfrey M. C. Taylor. Refers to T. R. Camp, W. Donaldson, H. P. Eddy, H. P. Eddy, Jr., G. B. Gascoigne.

Craig, Franklin Curtiss, Jun., Bonners Ferry, Idaho. (Elected May 12, 1930.) (Age 31.) Asst. Hydr. Engr., U. S. Geological Survey, Surface Water Div. Refers to F. C. Christopherson, I. C. Crawford, N. C. Grover, T. R. Newell, J. V. Otter, C. G. Paulsen, F. M. Veatch.

Deichler, Ludlow Vanderburg Clark, Jun., Atlanta, Ga. (Elected Oct. 29, 1934.) (Age 27.) Civ. Engr. and Gen. Contr. (acting as Estimator, Engr. and Gen. Supt.). Refers to L. F. Bellinger, R. B. Black, A. J. Cooper, G. M. Dillingham, C. D. Gibson, B. M. Hall, Jr., W. A. Hansell, F. H. McDonald, H. C. Seward, F. C. Snow.

Gayá-Benejam, Raul, Jun., San Sebastian, Puerto Rico. (Elected Nov. 28, 1932.) (Age 32.) Contr. Refers to M. Font, F. Fortuno-Selles, C. A. Garcia, R. A. Gonzalez, A. S. Romero, R. M. Snell, E. Totti y Torres.

Gewertz, Moe William, Jun., Los Angeles, Calif. (Elected Feb. 10, 1930.) (Age 32.) Asst. Bridge Constr. Engr., California Div. of Highways, Bridge Dept. Refers to C. F. Calhoun, A. Donaldson, R. R. Martel, F. W. Panhorst, F. Thomas, D. R. Warren, P. R. Watson.

Glassberg, Myron, Jun., St. Louis, Mo. (Elected March 30, 1931.) (Age 30.) Owner, Constructor Specialties Co. Refers to W. R. Crecelius, W. S. Hewett, H. Nagin, H. Shifrin, H. J. Stemm.

Green, Robert Reeder, Jun., Trenton, N.J. (Elected Nov. 14, 1927.) (Age 32.) Designer, Chemical Constr. Co. Refers to G. E. Beggs, C. S. Bissell, H. L. Bowman, M. Goodkind, S. J. Leonard, L. C. Petersen, E. K. Timby.

Harrold, John Coate, Jun., Washington, D.C. (Elected March 5, 1928.) (Age 32.) Engr., Office of Chf. of Engrs., U. S. Army. Refers to J. B. Alexander, C. H. Ellaby, A. F. Griffin, R. E. Mackenzie, W. H. McAlpine, G. M. Tapley, V. A. Vollmer, B. R. Wood.

Heyser, Alton Schulze, Jun., Riverdale, N.Y. (Elected Oct. 1, 1926.) (Age 32.) Res. Engr. Inspector, Federal PWA. Refers to M. E. Gilmore, S. G. Hess, E. R. Kent, P. H. Lovering, G. S. Rinehart, H. C. T. Toensfeldt, J. B. Wilbur.

Hose, Harold Clarence, Jun., Lockport, Ill. (Elected Nov. 14, 1927.) (Age 32.) Chf. Engr., The Texas Co., Port Arthur, Tex. Refers to R. A. Anderegg, P. Campbell, Jr., G. E. Crews, M. Halpern, H. B. Luther, W. C. Mundt, R. W. Renn.

Johnson, Weston MacLeod, Jun., San Francisco, Calif. (Elected March 11, 1929.) (Age 31.) Asst. Engr., Healy-Tibbitts Constr. Co. Refers to H. L. Baldwin, B. K. Curry, A. P. Denton, R. M. Fox, L. J. Jennings, C. T. Morton.

Johnston, Bruce Gilbert, Jun., New York City. (Elected July 23, 1934.) (Age 31.) Instructor in Civ. Eng., Columbia Univ. Refers to H. Cross, W. C. Huntington, H. D. Hussey, W. J. Krefeld, I. M. Lyse, F. E. Richart, C. H. Sutherland.

Kotta, Ray Joseph, Jun., San Francisco, Calif. (Elected Nov. 23, 1931.) (Age 32.) Civ. Eng. Inspector, Eng. Dept., Board of Public Works. Refers to O. W. Degen, W. S. Hassenmiller, R. W. Henry, S. W. Hulse, L. Larson, H. J. Stahle.

Le Van, James Henry, Jun., Chillicothe, Ohio. (Elected Oct. 1, 1926.) (Age 32.) Officer in Charge, Sciota River Investigation, U. S. Public Health Service. Refers to C. M. Everett, G. M. Fair, L. M. Fisher, A. E. Gorman, A. P. Loriot, H. G. Payrow, H. W. Streeter.

McKim, Robert Dan, Jun., Kansas City, Mo. (Elected Oct. 14, 1935.) (Age 32.) Designer with Black & Veatch, Cons. Engrs. Refers to E. Boyce, J. F. Brown, W. G. Fowler, F. A. Russell, N. T. Veatch, Jr.

Mann, Joseph, Jun., Miami, Fla. (Elected Oct. 24, 1932.) (Age 31.) Secy.-Treas., and Constr. Mgr., M & M Dredging & Constr. Co. Refers to G. S. Brockway, E. Friedman, M. B. Garris, R. W. Reed, C. T. Schwarze.

Ranta, Toivo Walder, Jun., Sacramento, Calif. (Elected Dec. 22, 1930.) (Age 31.) Asst. Topographic Engr., U. S. Geological Survey. Refers to L. L. Bryan, W. R. Chenoweth, E. D. Dake, H. H. Hodgeson, R. R. Monbeck, J. C. Rathbun, J. G. Staack.

Roake, Theodore Chester, Jun., Salem, Ore. (Elected July 8, 1935.) (Age 32.) Designing Engr., Oregon State Highway Comm. Refers to J. L. Franzen, C. B. McCullough, G. S. Paxson, A. G. Skelton, R. T. Stanley.

Seal, Benjamin Callison, Jun., Detroit, Mich. (Elected Oct. 26, 1931.) (Age 32.) Senior Civ. Draftsman, Sewage-Disposal Project. Refers to J. B. Alexander, J. H. Childs, E. A. Hardin, A. B. Morrill, J. W. Orton, H. P. Warren.

Smith, John Gibb, Jr., Jun., Philadelphia, Pa. (Elected Dec. 3, 1926.) (Age 32.) Salesman, Keystone Auto Club. Refers to P. S. Baker,

A. S. Craven, C. Dillenbeck, C. A. Howland, J. W. Moffett, C. W. Palmer.

Tucker, John Thomas, Jun., Helena, Mont. (Elected Oct. 26, 1931.) (Age 32.) Engr., PWA. Refers to B. Blum, C. Derleth, Jr., R. H. Fifield, S. T. Harding, T. H. Means, B. E. Torpen.

Voelker, Robert Andree, Jun., Yellow Springs, Ohio. (Elected Feb. 10, 1930.) (Age 30.) Instructor in Civ. Eng., Antioch Coll. Refers to A. Atkinson, E. L. Chandler, J. H. Kimball, H. N. Lendall, W. Rudolfs, P. B. Streander, W. G. Taylor.

Weidner, Charles Kenneth, Jun., Seattle, Wash. (Elected June 15, 1936.) (Age 32.) Asst. Supt., Bldgs. and Grounds, Univ. of Washington. Refers to T. D. Hunt, C. M. Jenkins, J. Kylstra, H. W. McCurdy, C. C. May, G. L. Youmans.

White, George Clifford, Jun., San Francisco, Calif. (Elected July 31, 1933.) (Age 27.) San. Engr., Wallace & Tiernan Co. Refers to A. C. Beyer, K. L. DeBlois, R. T. Gardner, T. P. Pendleton, L. P. Raynor, L. B. Reynolds, B. C. Wells.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1936 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

Structural Engineer; Assoc. M. Am. Soc. C.E.; 41; married; graduate civil engineer, 1921; registered New York State; 16 years progressive experience, building construction, steel and reinforced concrete, design of modern transatlantic piers (New York City) and construction supervision of same (5 years). PWA engineer for one year on hospital projects, including refrigeration plants and power-houses. Desires permanent position. Location in the East preferred. C-39.

DESIGN

Civil Engineer; Assoc. M. Am. Soc. C.E.; 44; married; New York State license; 13 years American experience, and 7 years European; structural steel and reinforced concrete design; industrial and office buildings, hotels, churches, railroad terminals, silos; harbors; flood control; arches; speaks French and German; wishes permanent position. C-38.

Structural Engineer; Jun. Am. Soc. C.E.; B.S. in C.E. (structures), 1927; registered professional engineer; age 31; 4 years structural steel and design experience with fabricator and engineer; $5^1/_2$ years with bridge department of state highway commission, specializing in continuous structures and frames, both concrete and steel. Available on reasonable notice. C-27.

EXECUTIVE

Civil Engineer; Assoc. M. Am. Soc. C.E.; seeks position as plant engineer in charge of maintenance, repairs, and alterations to buildings, machinery, and equipment. Capable and experienced executive with wide practical and technical experience. Licensed professional engineer. Age 43. Christian. Temporarily employed, but available on short notice. C-25.

Civil Engineer; M. Am. Soc. C.E.; married; over 20 years experience in charge of construction work, including mills, factories, hydraulic development, bridges, and heavy construction; also has had much experience in designing and estimating. C-28.

Industrial Plant Engineer; Assoc. M. Am. Soc. C.E.; 37; married; graduate civil engineer; licensed; 12 years in engineering departments of large paper companies at head office and mills; 1 year in Europe in steel shop with contractor. Design and plans for plant layout, material handling equipment, industrial buildings. Speaks German and French. Desires position with manufacturing concern. C-26.

Professional Engineer; Assoc. M. Am. Soc. C.E.; graduate civil engineer. Designer of steel, concrete, and timber structures; industrial, tall office, and mill buildings; warehouses, bridges, and viaducts (highway and railroad); steam and hydroelectric power plants; docks, railroad stations, and subways; flat slab buildings; and statically indeterminate structures. Capable of taking charge. C-44.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 37; married; 15 years experience on buildings, bridges, and sewage disposal plants; reinforced concrete, structural steel, and timber design; estimating and responsible charge of work. Available on two weeks notice for New York only. C-46.

JUNIOR

Civil Engineer; Jun. Am. Soc. C.E.; 27; single; B.S.C.E., Massachusetts Institute of Technology; special study of hydroelectric engineering and hydraulics; 3 years varied experience in triangulation, planimetric aerial mapping, soils mechanics, state planning, report writing (water resources), hydraulics, and river engineering. Desires position affording further training in hydraulics or related fields: location immaterial. Excellent recommendations. C-29.

Civil Engineer; Jun. Am. Soc. C.E.; 27; B.S.C.E.; graduate study in sanitary engineering; 4 years experience on water aqueduct, including supervision, inspection, surveying, estimating, and drafting. In responsible charge of WPA construction work for 14 months; now employed in civil service; desires change for position with more responsibility and opportunity. C-30.

Sanitary and Civil Engineer; Jun. Am. Soc. C.E.; 23; single; B.S. in C.E.; 3 months drafting; 3 months as chemist in large water works; 1 year as officer in Corps of Engineers, U. S. Army, with experience in teaching, planning military and civil works, and administrative details. Desires work in sanitary engineering. Location immaterial. C-31.

Engineer; graduate of Rutgers University, civil engineering, June 1935; age 23; 10 months experience as transitman on housing development; 3 months as draftsman, and checking calculations for model analysis; 6 months on supervision of layout of parts and sub-assembly. C-32.

Civil Engineer; Jun. Am. Soc. C.E.; single; B.S.C.E. degree; $1^1/_2$ years surveying; office and field work; 6 months engineering experience on waterline; storm sewer and road construction; 4 years drafting experience—layout and detailing. Desires position in construction engineering in metropolitan area. Available in 15 days. C-33.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 22; B.S.C.E., University of Southern California, 1936; 6 months in Los Angeles Bureau of Water Works and Supply, junior civil engineer in field laboratory; tunnel experience and earth tests; 3 years study of Spanish; would like position with contractor in South America; hydraulic development or structural. C-34.

Civil Engineer; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., New York University; $1^1/_2$ years surveying; $1^1/_2$ years on inspection with construction company; 1 year as inspector on flood-control projects; 6 months on problems in flood-control work; graduate studies in hydraulics. Location, eastern United States. Available on 2 weeks notice. C-35.

Civil Engineer; Jun. Am. Soc. C.E.; 27; married; B.S.E. and C.E. degrees; 4 years as general foreman on building construction and large alterations; 6 months as field instructor in surveying; 1 year as transitman, grading large tract, lines, and levels, and supervising laying of large steel pipe; compilation computing; desires opportunity in civil engineering. Available. C-36.

Young Man; 27; married; recent graduate, B.S. in C.E. Lacking experience, he would like to affiliate himself with a large construction firm where he will be given an opportunity to start at any low position and be advanced as he becomes proficient in the work. Speaks and writes Spanish. C-37.

Civil Engineer; Jun. Am. Soc. C.E.; 31; B.S. in C.E., Rutgers University, 1930; married; desires position in any branch of civil engineering, preferably in structural steel and concrete; $2^1/_2$ years experience in surveying and drafting. C-45.

TEACHING

Engineer; Assoc. M. Am. Soc. C.E.; age 42; M.S. and C.E. degrees; 2 years graduate work in structural engineering (recent). Practical experience in hydrographic and geodetic surveys, municipal engineering, sewerage, highways, design. Teaching experience in surveying and structural design. Now employed. Desires responsible teaching position; structures, surveying, geodesy, mechanics, engineering mathematics. C-40.

Civil and Structural Engineer; Jun. Am. Soc. C.E.; married; 30; C.E. degree; 6 years practical experience in structural design, steel, reinforced concrete. Thoroughly familiar with theory of indeterminate structures. Now in charge of designing and detailing large highway structures. Registered in civil and structural engineering. Desires teaching position. C-41.

Civil Engineer; Jun. Am. Soc. C.E.; 28; married; B.S. in C.E.; graduate fellow teaching surveying, and candidate for M.S. in C.E.; member of Tau Beta Pi, Phi Kappa Phi; $4^1/_2$ years experience in surveying; 3 months detailing and estimating reinforcing steel. Will consider any location. Available for appointment on civil engineering faculty for 1937 session. C-43.

Engineer; M. Am. Soc. C.E.; Tau Beta Pi; Presbyterian Church; Masonic Lodge; Ph.B., B.S., and M.S. degrees; 20 years technical engineering experience in teaching and practical work, chiefly structures and highways; now employed; desires position teaching civil engineering or mechanics. C-47.